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DECEMBER, 1939
No. 348
Vol. XLIII.

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The Journal of The Royal Aeronautical Society

With which is incorporated The Institution of Aeronautical Engineers

Edited for the Council by Capt. J. LAURENCE PRITCHARD, Hon. Fellow

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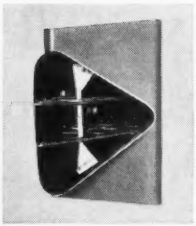

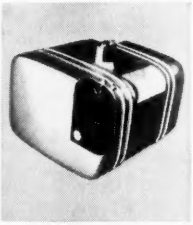

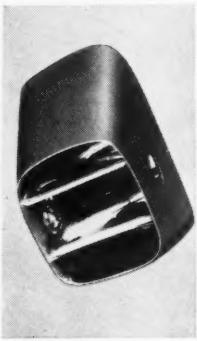

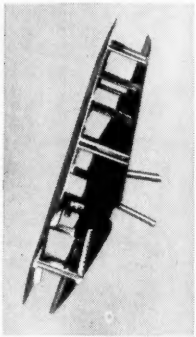

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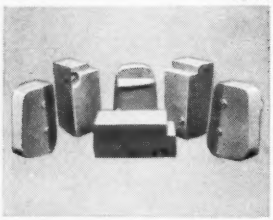

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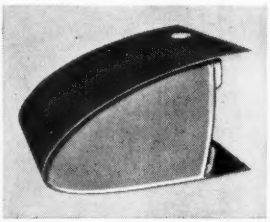

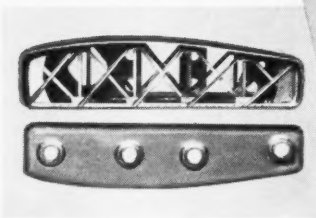

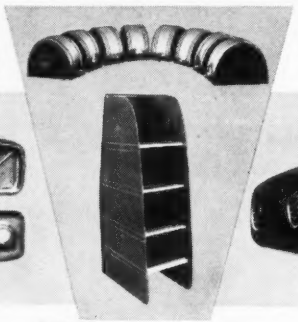

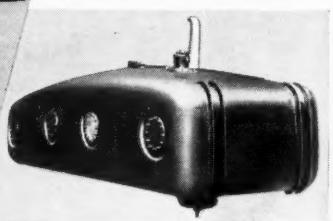

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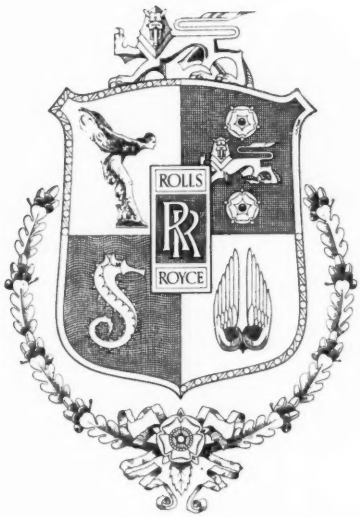

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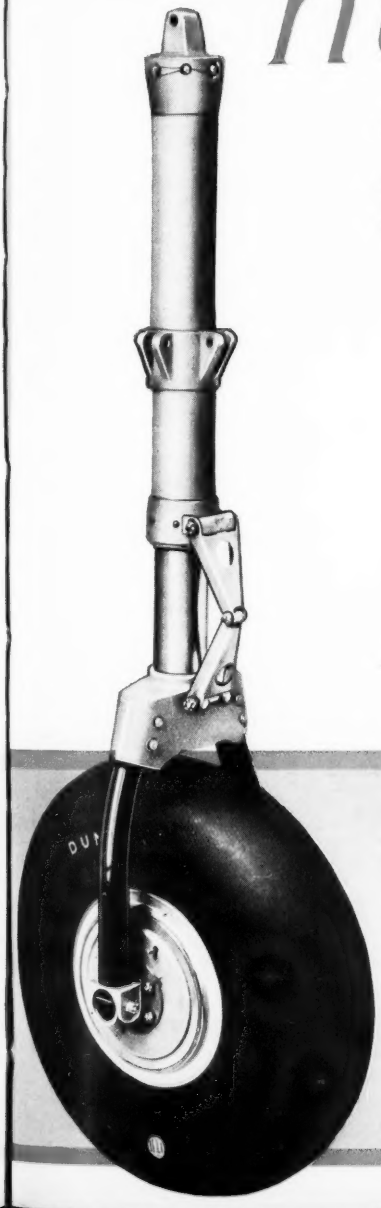

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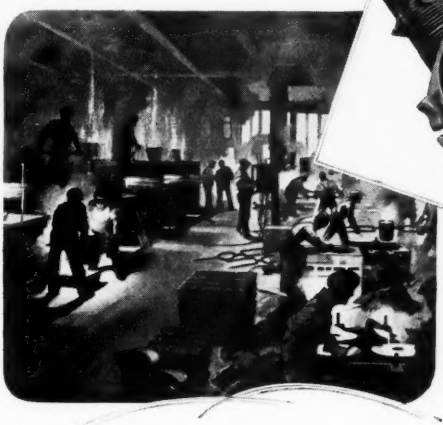

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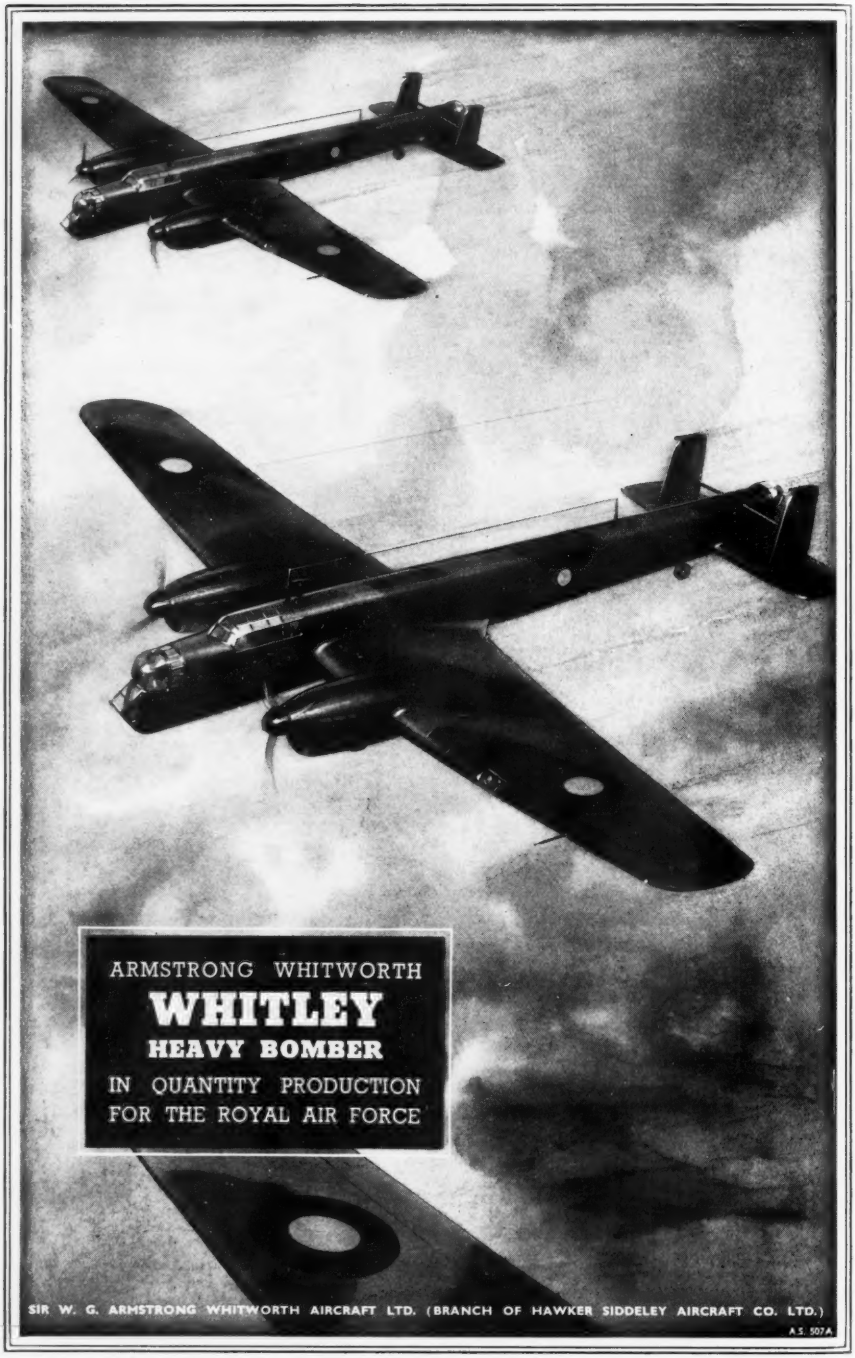
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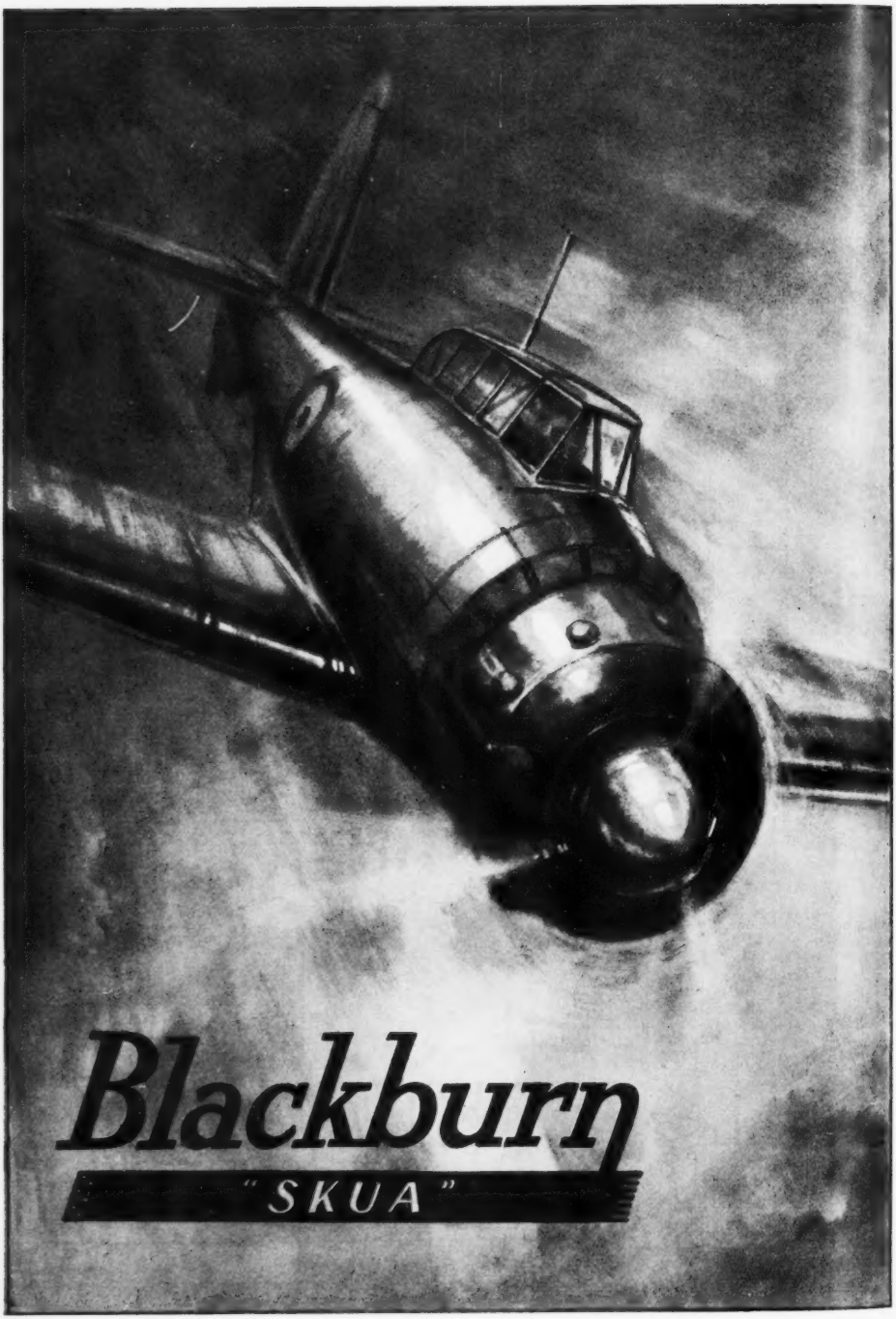
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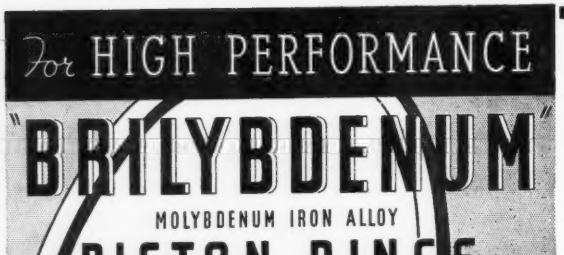

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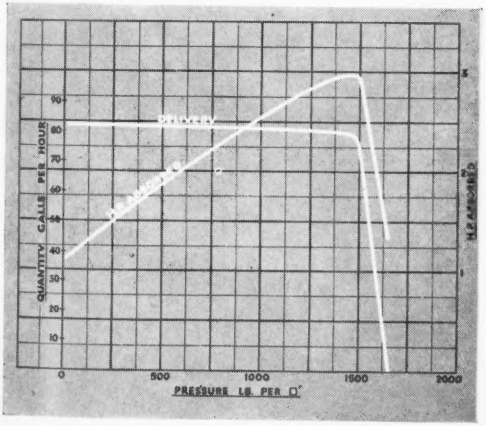

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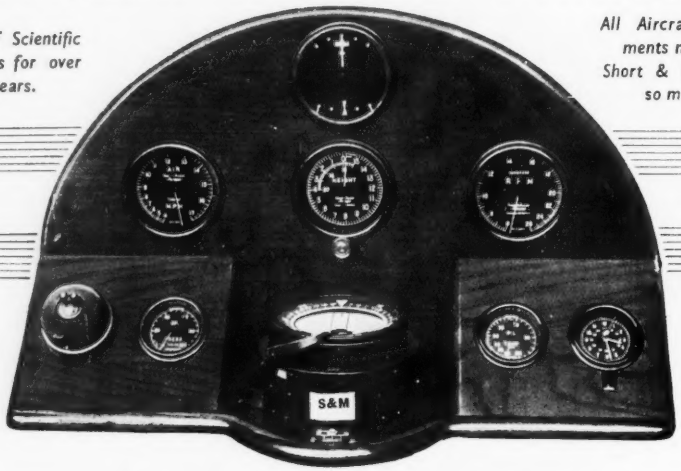

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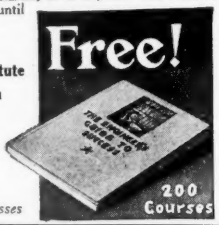

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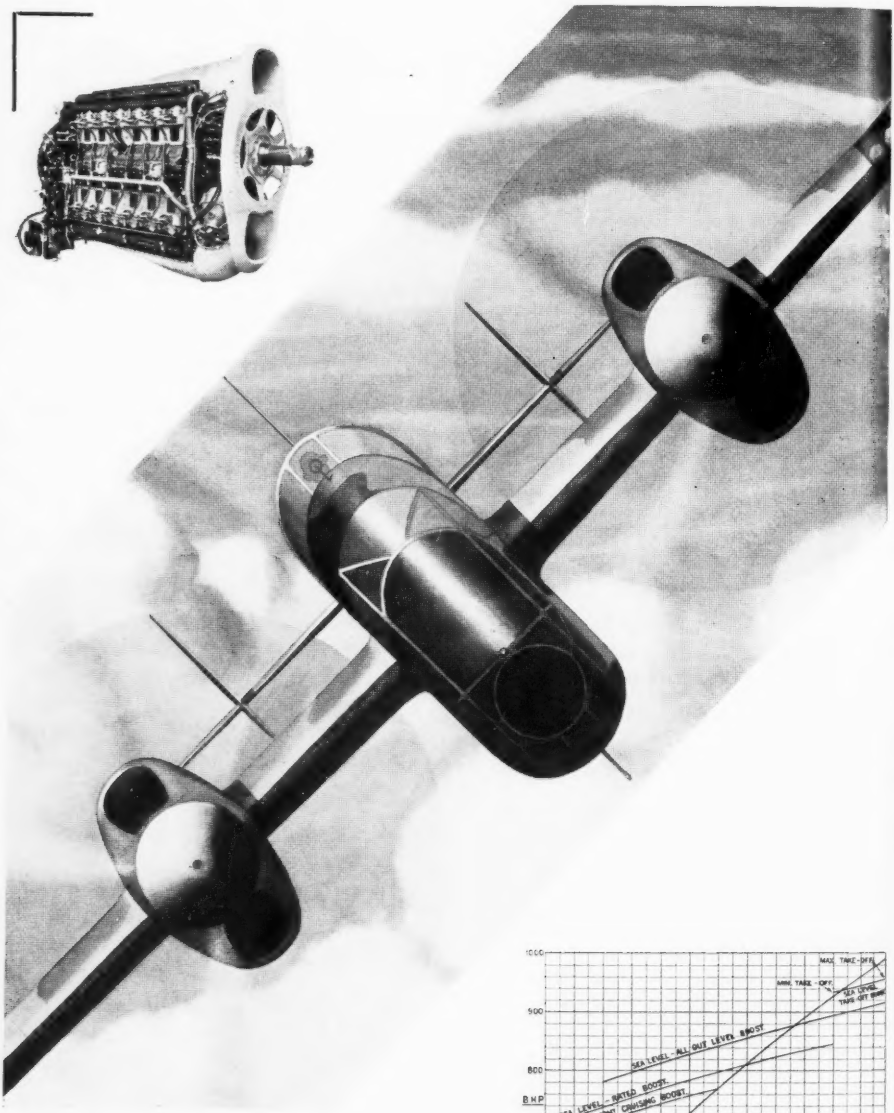

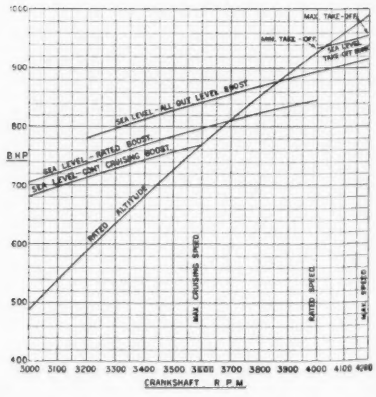

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THE JOURNAL OF THE ROYAL AERONAUTICAL SOCIETY *was founded in* 1897 *in succession to the* ANNUAL REPORTS.

For the opinions expressed in Papers that are signed or initialled the authors alone are responsible. None of the Papers or paragraphs must be taken as expressing the opinion of the Council of the Royal Aeronautical Society, unless such is definitely stated to be the case.

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All communications for publication in the Journal, or on general matters affecting the Society should be addressed to—

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MONTHLY NOTICES

DECEMBER, 1939.

Christmas Holidays.

The Offices and Library of the Society will be closed from Friday evening, December 22nd, until Wednesday morning, December 27th, 1939.

Emergency Address.

During the period of the war correspondence may be addressed either to headquarters or to the Society's country address, Brook House, Old School Lane, Brockham. (Telephone Betchworth 189.)

History of the Society.

The Secretary is collecting material for a detailed history of the Society since its foundation on January 12th, 1866. He will appreciate anything of interest bearing on the Society's history and the loan of any letters or documents which will be copied and returned. He would particularly welcome any personal reminiscences of meetings of the Society and its unrecorded activities during the period 1904—1914 and any letters, circulars, newspaper references, or papers relating to the Society before 1904.

Examinations.

The Society's examinations will be held on December 19th, 20th, 21st and 22nd at the City and Guilds (Engineering) College, South Kensington. The Examinations are also being conducted in Canada, Ceylon, India, New Zealand and South Africa.

Election of Members.

The following Members were recently elected:—

Fellows.—Leonard Frederick George Butler, Leslie Leroy Irvin.

Associate Fellows.—William Donald Arnot, Edward James Brandon, Albert John Brant, Herbert William Jordan Brittlebank, George Barnhill Burnside, Mohamed Aly Cherif, William John Colyer, Frederick William David, Denis Pierpoint Edkins (from Student), Stanley Wason Lane, John Robert Lewin, David Ketchen Marshall, Mansel Thomas, George William Williamson.

Associates.—Patrick Michael Seymour Aldham, Herbert James Allard, Milne Edington, Laurence Richard Morphew (from Student), Albert James Payne, William George Percy Rogers.

Graduates.—Nevil James Ashton (from Student), Granville Clifford, George Noel Fraser Luckie (from Student), Harry Hall Smith (from Student), Peter John Thursby (from Student).

Students.—Henry Verner Becker, Robert Allan Millar Craig, Arthur Frankish, Eric Martin Goodger, Douglas Cole Greenwood, David Matthew McElhinney, Leslie Morgan, Peter George Stannard, William Stuart Sutherland, Eric Herbert Whiteley, Harry Stanley Viney.

Companions.—Ronald Frederick Scott Pearson, Anthony Noel Sergeant.

Acknowledgments.

The Council acknowledge with very grateful thanks the gift of an early Patent Specification (November 1871) dealing with Aerial Navigation taken out by Mr. Thomas Moy and Mr. R. E. Shill presented to the Library by Mr. V. A. M. Hunt (Student), the gift of a programme of the first Flying Meeting held in this country at Doncaster from Mr. Wedd of Wilmslow, Cheshire, and back copies of "The Aeroplane" and "Aircraft Engines" from Mr. W. S. Hollyhock (Associate Fellow).

Corrections.

In the paper on Experimental Research in Guidonia Supersonic Wind Tunnel, C_L should read $L\ \rho V^2 S$ and C_D, $D\ \rho V^2 S$.

Elliott Memorial Prize.

The Elliott Memorial Prize has been awarded to Aircraft Apprentice C. L. Brooks, who has obtained the highest marks in the General Studies Examination Paper of the Final Passing Out Examination at Halton.

Diary Refills.

Refills for diaries obtained in previous years are available at 1s. 0d. each. New diaries will not be available this year.

Additions to Library: November, 1939.

India Meteorological Department: Scientific Notes:—

No. 81. Vertical currents in the first few kilometres over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate. By K. P. Ramakrishnan. 1939. 10d.

No. 82. An analysis of Indian rainfalls using the median as a statistic. By L. S. Mahalingam. 1939. 1/-.

National Advisory Committee for Aeronautics:—

24th Annual Report, 1938. (Containing Technical Reports Nos. 612-644.) N.A.C.A., Washington (U.S.A.). $2.25.

National Research Council of Canada:—

21st Annual Report, 1937-38. (N.R.C. Publication No. 807.) Ottawa, 1939. 75c. Index to Publications (1918-1938.)

Nationaal Luchtvaartlaboratorium, Amsterdam:—

Report No. V. 1162. De Nauwkeurigheid van Hoogtebepalingen van Vliegtuigen, gebaserd op Atmosferische Gegevens. (The Accuracy of Altitude Calculations in Flight, based on Atmospheric Data.) By Dr. H. J. van der Maas and Dr. J. H. Greidanus. (Stencil.)

National Central Library:—

23rd Annual Report. (1938-39.)

Institut de Mécanique des Fluides de l'Université de Lille: Publications:—

No. 54. Influence du mouvement périodique transversal du bord d'attaque d'une aile d'avion sur la réaction exercée par le fluide. By Henri Guillemet. (Extract from Comptes Rendus de l'Académie des Sciences. May 8th, 1939.)

No. 58. Sur les modifications de la force subie par une aile en translation dans un fluide quand le bord d'attaque est animé d'un mouvement périodique suivant l'envergure. By Henri Guillemet. (Extract from "La Science Aérienne," July/August, 1939.)

Atti di Guidonia: (Editoriale Aeronautica, Rome):—

No. 11. Carico critico di Punta delle Aste Euleriane Semincastrate. By C. Riparbelli. 1939. Lire 3.

Royal Meteorological Society: Memoirs:—

No. 40. Correlations between Monthly Rainfall at Eleven Stations in the British Isles. By D. A. Boyd. 1939. 2/6.

Guggenheim Aeronautics Laboratory, Pasadena: (U.S.A.) Publications:—

No. 116. An Investigation of the Conditions for the occurrence of Flutter in Aircraft; the development of Criteria for the Prediction and Elimination of such Flutter. By A. E. Lombard, Jnr. 1939.

Aircraft Yearbook for 1939. The Aeronautical Chamber of Commerce, U.S.A. $5 (U.S.A.) or $6 (abroad).

Cylinder Wear, with special reference to Liner Materials. By Gwilym Williams. Mond Nickel Co. 1939 (Pamphlet.)

Final Report by the Rt. Hon. Sir Nevile Henderson, G.C.M.G., on the circumstances leading to the Termination of his Mission to Berlin. (September 20th, 1939.) (Cmd. 6115.) H.M.S.O., 1939. 3d.

The Lag Coefficients of some Meteorological Thermometers. By W. E. Knowles Middleton, H. W. Edwards and H. Johnson. American Meteorological Society Bulletin, October, 1938. (Reprint.)

On the Theory of the Ceiling Projector. By W. E. Knowles Middleton. August, 1939. (Reprint.)

Raiding by Celestial Navigation. By Francis Chichester. Henry Hughes and Son, 1939. (Reprint from "Flight," August 17, 24, 31, and September 14.)

Red Pilot. By Vladimir Unishevsky. Hurst and Blackett, 1939. 7/6.

Static Electricity in Relation to Refuelling in Flight. By Marcus Langley. Flight Refuelling, Ltd. 1939. (Pamphlet.)

The World of Wings and Things. By Sir A. Verdon-Roe. Hurst and Blackett, 1939. 7/6.

J. LAURENCE PRITCHARD, *Secretary and Editor.*

The 646th Lecture read before the Royal Aeronautical Society since its foundation on January 12th, 1866.

PROCEEDINGS.

A meeting of the Royal Aeronautical Society was held in the Lecture Hall of the Institution of Mechanical Engineers at Storey's Gate, Westminster, London, S.W.1, on Thursday, March 30th, 1939, when a paper on "The Problem of Ancillary Power Services on Aircraft" by Mr. R. H. Chaplin, B.Sc., A.F.R.Ae.S., and Mr. F. Nixon, B.Sc., A.F.R.Ae.S., was presented and discussed.

In the Chair: Mr. A. H. R. Fedden, President of the Society.

The PRESIDENT: The two authors would deal with the subject from the angles of the engine and the aircraft, and he was quite sure there woud be an instructive discussion. The problem of ancillary equipment for both civil and military aircraft during the last three or four years had become extremely complex. There were so many ways of doing this job and so many opinions about it that a paper of this sort must do a great deal to bring light upon the problems to be faced. The authors were both Associate Fellows and the Society was fortunate in having men who, in addition to a considerable amount of experience in their own special fields of design, had also had practical works experience.

Mr. Chaplin, who studied at the University of London, served two years with the Royal Engineers during the last war. For the past thirteen years he had been with the Hawker Company and now held the position of Assistant Chief Designer.

Mr. Nixon, after leaving Manchester University, obtained his practical experience and then spent two years in the Royal Aircraft Establishment, Farnborough, before he joined his present firm, the Bristol Aeroplane Co. Ltd., where he had been engaged for ten years on engine problems.

THE PROBLEM OF ANCILLARY POWER SERVICES ON AIRCRAFT.

By R. H. CHAPLIN, B.Sc., A.F.R.Ae.S., and F. NIXON, B.Sc., A.F.R.Ae.S.

PART I.

THE AIRCRAFT VIEWPOINT.

By R. H. CHAPLIN.

SUMMARY.

(1) Introductory and General Explanation.
(2) Definition.
(3) Historical.
(4) Present Position Summarised.
(5) Reduction in Number of Services.
(6) Retention of Electricity and Hydraulics only.
    (6.1) Reasons for Supplementing Electricity by Hydraulics
    (6.2) Replacement of Vacuum and Compressed Air.
    (6.3) Reasons for Elimination of Vacuum and Compressed Air
(7) Independent Power Unit for Services.
(8) Nature of Electrical Service.
    (8.1) High Frequency High Voltage Alternating Current.
    (8.2) Alternating Current of Normal Voltage and Frequency.

(9) Main Power Unit or Units as Source of Energy.
  (9.1) Scheme (*a*) Electrical Generator only.
  (9.2) Scheme (*b*) Electrical and Hydraulic Generators.
(10) Review of Hydraulic Situation, Present and Future.
(11) Emergency Operation.
(12) Final Summary.

(1) Introductory and General Explanation.

Before embarking upon the business of this paper I should like to make one or two general remarks by way of explanation.

It was suggested by two members of the Council that the present situation with regard to ancillary power services on aircraft was far from satisfactory, and that the question might well form the basis of a lecture before the Society; moreover, that such a lecture might be more interesting and valuable if presented as a joint paper by a member of an engine firm and an aircraft firm respectively. Mr. Nixon and myself have had the honour of being asked to collaborate in this connection and we trust the result will be acceptable to you.

Probably more valuable than the lecture itself, should be the ensuing discussion. We, the lecturers, have made an effort to keep our talk as short as reasonable in order that plenty of time shall be available for that discussion.

Finally, I would say that the subject as we shall be treating it to-night does not entail specialised knowledge, and as the purpose of this lecture is largely to create an opportunity for members of the aircraft profession to voice their views, we hope that participation in the discussion will be general.

(2) Definition.

We realise that the title of this paper may be a little indefinite, but it the best we could find to cover our subject in those few words.

All we need make clear is what is meant by the words "power services." A "service" for the purpose of this paper refers to the means of transferring energy from one part of the aircraft to another.

We exclude from this all services which do not derive their energy from the engine. Thus, manually energised flight and engine controls, pipe lines for oxygen, CO_2, pitot head, etc., are outside the scope of this lecture.

(3) Historical.

I suppose the earliest form of service subscribing to the above definition, to be found in general use, was the electrical system which derived its power from a windmill driven generator mounted on the aircraft in the air stream. With the development of the aeroplane and the demand for more electrical power, followed closely by the advent of a more aerodynamically clean form, the windmill became replaced by the engine driven generator.

It soon became apparent with high landing speeds on relatively heavy aircraft, that effective brakes were necessary. Foot or manual operation unassisted by some form of power servo was not good enough. A satisfactory solution was the air operated brake fed from a storage bottle. It was only natural that ultimately an engine-driven compressor should be fitted to keep this bottle charged.

More recent is the development of retractable undercarriage and flaps. Although not the only way to operate these devices, there is no denying that the use of hydraulics proved very convenient and met with immediate and fairly general adoption. The engine-driven hydraulic pump was practically essential to this scheme.

Lastly, I must add a note with regard to the vacuum pump. Several years ago gyroscopically operated instruments were introduced on aircraft. A convenient method of maintaining the rotation of the gyroscope was by utilising a

vacuum, or perhaps more accurately, a source of atmospheric depression. This was very ingeniously and simply provided by installing a venturi externally on an aircraft in the air stream. Subsequent events have demonstrated that the venturi can be readily choked in ice-forming conditions, that its action is indefinite on the turn with multi-engined aircraft due to blanking, and that it is not fully effective for an appreciable interval of time after take-off, all of which are conditions when these very instruments are so essential. An engine-driven vacuum pump was naturally resorted to.

4. Present Position Summarised.

Thus we have four main services on aircraft, namely:—

1. Electricity.
2. Compressed air.
3. Hydraulics.
4. Vacuum.

Although (2) and (4) are both pneumatic, I class them as separate services, since one is not related to the other as high is to low pressure compressed air or high is to low pressure hydraulics.

As referred to in my previous sentence these four main services are further complicated, and, should we say, multiplied by each having its own variation in matters of pressure. There is no denying the fact that this multiplicity of services does not facilitate the work of either the engine or aircraft manufacturer. The fact that standardisation is impossible to any worth while degree must increase the cost of manufacture and in these days of national emergency the interference with production is serious.

It is our problem to-night to review the situation and try if possible to make some constructive suggestions for the future, both immediate and the more distant.

(5) Reduction in Number of Types of Services.

The first question is, "Are all these services essential?" The answer is, "They are not." We must see which ones can be eliminated and try to form an opinion as to whether their elimination is justified.

Perhaps it would be well to enumerate the requirements of a comprehensive power service. It should be:—

1. Light in weight.
2. Reliable (with which we might associate not vulnerable).
3. Compact.
4. Efficient (that is, small power loss in transmission).
5. Simple (although this can be taken as a general comment, the installation and keeping in repair are probably most important from this standpoint).
6. Cheap.
7. Capable of storing energy (to meet the exigencies of failure of the source of supply).
8. Capable of performing both mechanical and essentially electrical tasks (by the latter is meant the operation of lamp bulbs and wireless).

This last mentioned clause calls for the retention of the electrical service and I am sure no one will argue with this.

What of the remaining—compressed air, hydraulics, and vacuum? Can we dispense with these altogether, or do we need any or all of these? I make bold to suggest that we do need one, namely, hydraulics, and that with this and electricity as primary services we can satisfactorily perform all the tasks we need. I propose to adopt this suggestion as a basis and examine the problem from this point of view.

(6) Retention of Electricity and Hydraulics Only.

In making this proposition there are three questions to be answered.

1. Why is it necessary, or perhaps we should say, desirable from the aircraft designer's point of view, to supplement electricity with hydraulics?
2. Can the remaining two services, namely, compressed air and vacuum be satisfactorily replaced by electricity and hydraulics?
3. Is there sufficient justification to warrant the elimination of compressed air and vacuum?

(6.1) Reasons for Supplementing Electricity by Hydraulics.

Dealing with the first question, hydraulics has a great deal to recommend it and has virtues which electricity cannot claim.

First and foremost is the question of weight. The apparatus for turning electrical into mechanical energy, namely, the electric motor, is heavy even in its most highly developed state and does not compare favourably with the hydraulic jack. I suggest this is fundamental and insurmountable. The plain fact is that the size and weight of a hydraulic jack is dependent upon the amount of energy per stroke it is capable of handling and not upon the horse-power developed. Thus we might have a small jack of, say, 1in. bore by 4in. stroke operating during part of its stroke at 2.2 h.p., which is the horse-power developed by the popular Lockheed Mk. IV hydraulic pump at 1,400lbs. per sq. in. at 1,300 r.p.m. This jack would weigh, say, 1.5lbs. whereas an electric motor of the same power would probably weigh 15lbs. or so.

It should be noted here that most of the duties we should require of hydraulics are those capable of being performed by jacks. There are, however, certain duties which entail the use of more or less continued operation, that is to say, a true motor must be employed. Although the weight difference is not so glaring in these circumstances we still find a saving in favour of the hydraulic unit. Thus we have in existence to-day a hydraulic motor of 1.5 h.p. weighing 7lbs., whereas the equivalent electric motor weighs some 12lbs. Even better is a certain hydraulic motor, at present in the development stage, developing approximately 3.0 h.p. and weighing 10lbs. against the 20 to 25lbs. of an electric motor of the same horse-power.

Probably the next important virtue of hydraulics is in the facilities for starting and stopping. Although it is allowable on small electric motors to apply directly the full mains voltage, it is generally necessary to provide proper starting equipment. The counterpart on a hydraulic system is a comparatively simple cock or valve. With regard to stopping, some special provision must be made in the case of an electric motor, whereas the piston of a jack can be arrested almost instantaneously by virtue of its small momentum.

The facility with which the " gear ratio " on a hydraulically operated unit may be adjusted—by modifying the bore and stroke of the jack—has been put forward as an advantage of hydraulics; I feel that this is justifiable, although some may argue that an electric motor with a modified rating, or the alteration of mechanical gearing, should be no more difficult for an electrical component manufacturer catering for aircraft, if tackled in the same spirit as that shown by those producing hydraulic apparatus for aircraft.

In the present state of development there is no doubt that the hydraulic jack does provide the easier answer.

Still another advantage of hydraulics is the ease with which the force to be applied to an aircraft mechanism can be limited by the interposition of a blow-off valve. A typical example of this is in the case of flaps, where it is undesirable for them to be held in the down position above certain speeds. Then again, in the operation of an undercarriage, a radiator flap, and also the landing flaps mentioned above, it is essential to provide some " safety valve " at the end of

the stroke to prevent structural damage. This is not so simple with electric operation.

All the foregoing refers generally to the virtues of hydraulics. There are, of course, many specific cases, of which we can take, as typical, that of brake operation. I agree that this probably can be done electrically, but I submit not so simply and satisfactorily as it is done hydraulically.

(6.2) Replacement of Vacuum and Compressed Air.

Having thus dealt with the reasons for supplementing an electric service with a hydraulic one, we will now pass on to the second question—" Can the vacuum and compressed air services be satisfactorily replaced by electricity and hydraulics?" I am a little diffident in tackling this problem as it involves considerable knowledge and experience in the niceties of certain types of specialised mechanisms.

I believe I am correct in stating that in this country the vacuum service is used chiefly to operate gyroscopically-controlled flying instruments. Apart from this particular type of instrument which is to be found on the instrument panel, gyros constitute an essential part of the automatic pilot apparatus. The well-known R.A.E. automatic pilot is pneumatically operated and the Sperry apparatus depends upon air plus hydraulic for its operation. However, I have been given to understand, by one who is qualified to express an opinion, that the design of satisfactory electrically driven gyros is not impossible and we have at least one automatic pilot apparatus, the Alkan, of French origin, which is so operated.

Mention of the R.A.E. automatic pilot brings me to the question of compressed air as distinct from vacuum. This apparatus is driven off the R.A.E. compressor which works at 35lbs. per sq. in. Another compressor, perhaps better known than the R.A.E. because of its more general application, is the B.T.H. type, operating at 200lbs. per sq. in. One of the most popular duties of this latter compressor is that of charging an air bottle for brake operation, a duty which, as I have previously mentioned, can be performed quite efficiently by hydraulics.

(6.3) Reasons for Elimination of Compressed Air and Vacuum.

The third and last question was, " Is there sufficient justification to warrant the elimination of compressed air and vacuum?" To this I can only reply generally that some simplification and reduction in the number of services is essential for cheapness, standardisation and production, and that it appears to me that the claims of vacuum and compressed air for retention are very small. From the aircraft designer's point of view it must be an advantage to effect so great a reduction in the number of types of services. Pipe systems with their multiplicity of materials, gauges, couplings, valves, etc., would be considerably reduced, thus avoiding the necessity for specialisation in so many directions in a design staff. The stores and works problems must also be inevitably eased. Again, from the aspect of maintenance, this elimination of two services cannot fail to be an advantage both with regard to training and operation of personnel. Perhaps, however, as great a saving would be amongst the engine people and those in official authority whose business it is to approve the various accessories associated with these two apparently non-essential services.

Although by no means a universal opinion, I find many people feel that for such and such an application the so and so service is ideal and that it will not be possible to design a mechanism so efficient as the present type if a particular form of power service is eliminated. This I feel is merely adopting a defeatist outlook, making any change from existing standards impossible. A certain lapse of time is, of course, necessary to develop new designs, but I do not think we should lose sight of the fact that small sacrifices, with regard to some of the virtues of the old design, may be worth while if some simplification is achieved.

(7) Independent Power Unit for Services.

Perhaps at this juncture we should examine a proposition which has a vital bearing on the whole subject of this paper, and which, owing to its basic nature, should perhaps be considered before we can pass on to issues of a more general nature. I refer to the suggestion of installing a power unit, entirely separate from the main engine or engines, comprising a petrol engine of, say, 30 h.p. or so, direct coupled to an electric generator and perhaps a hydraulic generator. Maybe the advantages are considerable and fairly obvious, but it cannot be said that it is of much advantage to the aircraft designer; all he wants is a service and the less interference with the layout of the aircraft the better.

Although possibly not weighty evidence against the idea, the fact remains that at the present time no entirely satisfactory design exists and it will certainly take a considerable time to perfect such a unit. The scheme has been applied to certain aircraft in America and, I believe I am correct in saying, the unit has not proved an unqualified success. I feel, however, that its greatest disadvantage is its non-applicability to small and medium-sized aircraft. If we take an all-up weight of 50,000lbs. as a minimum size of aircraft in which such a unit could be installed, it will readily be appreciated that a great number—perhaps we might say the majority—of aircraft cannot be so equipped. A solution must be found for the smaller aircraft and having found that solution I suggest it is probably undesirable to utilise an entirely different scheme for the larger types.

(8) Nature of Electrical Service.

Intimately bound up with the foregoing proposition is the whole question as to the nature of the electrical service and I feel that this is an appropriate stage at which to review this matter. The use of alternating current has been advocated for the electrical service on aircraft. It is well to remember in this connection that the generation of A.C. involves the use of a constant speed prime mover. That is to say, the adoption of a separate power unit becomes imperative, the main aircraft engine being unacceptable in view of the wide variation of r.p.m. under which it operates.

(8.1) High Frequency High Voltage Alternating Current.

Great claims have been made for high voltage, high frequency alternating current supply as has been applied to certain large aircraft in America. In the special case I have in mind, the service is at 120 volts with a frequency of 800 cycles. Before there can be any question of general adoption, I suggest this calls not only for careful consideration, but also for some worthwhile experience in everyday use, so that practical difficulties, which may have been glossed over in theory, may be given an opportunity to display themselves.

It is claimed for high voltage high frequency supply that there is:—

1. A reduction in the weight of machinery and conductors.
2. Simplification of power supply equipment for wireless receiving and transmitting apparatus.

There is insufficient time this evening to go into great detail, but the following points are worthy of consideration from the disadvantage point of view. Firstly, with regard to high voltage:—

1. Owing to the increase in insulation necessary, little, if any, weight is saved on the relatively small conductors used in aircraft.
2. There is increased danger due to insulation breakdown, particularly if moisture is present which will encourage a leak and lead ultimately to a fire when the the insulator burns.
3. Short circuits at a low voltage cause only the failure of the supply, but at high voltage they are dangerous due to arcing, which can occur. This is especially important on military aircraft where the risk of damage by enemy gunfire is great.

4. There is a lack of robustness in the filaments of lamp bulbs for the low powers used on aircraft.

And secondly, with regard to high frequency:—

1. It would not be possible to check equipment from an ordinary mains supply on the ground.
2. Although much commercial plant exists for normal frequency, none of this could be applied to aircraft use.
3. The higher the frequency, the more troubles there are to be faced with regard to insulation. The effect of any lack of dielectric uniformity is much more serious and acoustic phenomena at these frequencies are sufficient to result in a ruptu[illegible].
4. High frequency can give rise to a musical note which is troublesome to eliminate from wireless and telephone installations.

(8.2) Alternating Current of Normal Voltage and Frequency.

In view of the foregoing it may not be wise to stray far from the standards we know without extreme caution. However, it would not be fair to leave this subject without considering alternating current of normal voltage, say 24, and the standard frequency of 50 cycles. Does a service of this nature offer advantages sufficient to justify the adoption of the separate power unit, which we know is applicable only to the larger craft, and place us in the position of having two ranges of electrical equipment, namely, D.C. for small aircraft and A.C. for large types?

What are these advantages? They appear to be as follows:—

1. The ease of obtaining a change in voltage by the use of static transformers. Why we should wish to do this I have not been able to find out, except, of course, in the case of wireless equipment.
2. The ability to employ squirrel cage motors, thus avoiding brushes or collectors which, in the D.C. motor, involves the adoption of special measures to overcome wireless interference and danger of fire, both due to sparking.
3. The facility for the use of distant reading instruments with the Autosyn type of operation.

I suggest these advantages are outweighed by the following disadvantages, which are in addition to those specifically connected with high voltage and high frequency:—

1. The necessity of employing a separate power unit.
2. The resulting difference in the electrical services on large and small aircraft.
3. The inability to operate wireless in the event of failure of the generating unit, either in the air or subsequent to a forced landing.
4. The complications involved if it is desired to provide emergency battery operation for plant normally working off the A.C. supply.

In view of these observations I submit that the case for alternating current supply, whatever the voltage and frequency, is not good enough and it is better to deal with the devil we do know than the devil we do not know. I suggest that the present 24 volt D.C. system should be standardised until indications are sufficiently convincing that another type of electric supply is preferable.

(9) Main Power Unit or Units as Source of Energy.

To return to the more general problem, we will assume we have an electrical generator and may be a hydraulic generator which are to be driven off the main power unit or units. Speaking in a broad sense, there appear two methods of arranging this:—

(*a*) One drive for an electrical generator only, delivering all the energy necessary to operate all the power services on an aircraft, or alternatively,

(*b*) Two drives on the engine for electrical and hydraulic generators respectively.

(9.1) SCHEME (*a*) ELECTRICAL GENERATOR ONLY.

Scheme (*a*) is a rather attractive and a possible solution. There would, of course, be a standardised range of two or three sizes of electrical generators to meet the varying power service demands on all types of aircraft. The engine builder would have to provide one drive only, large enough to transmit the power of the largest generator, and there his responsibilities would end. Whether the generator could be mounted on the engine itself is questionable owing to its relatively large size. This would in general be an advantage, but, no doubt, should this prove impracticable, the aircraft designer would have to provide the necessary mounting for this generator on the aircraft. I should like to interject at this point with a reference to the accommodation on small aircraft, of the single-seater fighter class, of the large independent engine accessory such as just visualised, or the accessory gearbox being introduced at the present time. Owing to the small size of this particular type of aircraft, the fundamental necessity of keeping the overall dimensions small, it is almost impossible to find a space of sufficient size near the engine to receive a unit of this magnitude. A generator more or less integral with the engine is therefore extremly attractive for aircraft in this or a similar category.

One presumes that the provision of an electrical generator only would give support to the development of efficient electrical operation for aircraft mechanisms. However, as I have previously remarked, there are numerous duties so well suited to hydraulic operation that I feel it is unlikely we shall see this method entirely supplanted by electricity. If, as I imagine, we should find suitable electrical equipment does not come along, the " electrical generators only " scheme could still be applied by accommodating a hydraulic generator of sufficient size somewhere on the aircraft, where it would be driven by an electric motor energised from the main electrical supply.

I suggest this is not an economical solution and definitely unattractive. It hardly seems reasonable to have a relatively large electrical generator on the engine and then install an electric motor of almost the same power as the generator to operate the hydraulic pump. These observations bring us automatically to the second alternative.

(9.2) SCHEME (*b*) ELECTRICAL AND HYDRAULIC GENERATORS.

This seems to me the most practical compromise and, although capable of almost immediate application, I see little reason why it should not survive as the best arrangement for a considerable time. I would ask your special attention to this proposition as it forms a convenient basis for subsequent discussion this evening.

The suggestion is to drive two generators, namely, an electric and a hydraulic one from the engine. Preferably these should be mounted on the engine itself provided the overall shape and dimensions of the engine unit were not unduly affected. One of the main reasons for the separate gearbox unit disappears as the number of service connections to be broken when an engine is removed is so few as to be little trouble. Should, however, the installing of the units on the engine itself prove an appreciable source of trouble to the engine people, these same two generators would, of course, have to be mounted on a separate gearbox.

Almost immediate application of the scheme can be achieved by utilising small electric motor-driven units in the aircraft for vacuum and compressed air where there has not been sufficient time to re-design certain mechanisms to operate electrically and/or hydraulically, and there is no satisfactory existing design so operated.

The fact also that there are in existence certain hydraulically operated units, designed to work off a low pressure hydraulic service at 300lbs. per sq. in. in

addition to the more general hydraulic service at up to 1,400lbs. per sq. in., need not constitute a difficulty. These two services working at such different pressures are not generally to be found on any other than multi-engined aircraft, in which case a high and a low pressure hydraulic pump would be driven respectively by each of the engines of a twin-engined machine.

(10) Review of Hydraulic Situation, Present and Future.

It may come as a surprise to many to know that aircraft are under construction to-day, admittedly comparatively large aircraft, which carry hydraulic equipment weighing nearly half a ton and comprising as many as five independent hydraulic services. Surely something must be done to make it possible to avoid this sort of thing. Although hydraulic operation is sufficiently attractive in its present state of development to ensure its continuance, we have still a long way to go before we approach perfection in this service.

I would here like to voice a plea for the development and standardisation of higher working pressures for hydraulic equipment. I know this sounds paradoxical since development and standardisation appear incompatible, but on further thought this is not necessarily the case. There seems little justification for the systems at 300lbs. per sq. in. and even lower still employed for special purposes, beyond the fact that pumps and motors at higher pressures of sufficient power had not been developed when their need first became apparent. Since then many have been developed and there is no particular difficulty to-day of producing a hydraulic pump or motor operating at relatively high pressure with the necessary output of power. In that case the popular 1,200-1,400lbs. per sq. in. pressure could well be standardised to-day. This, however, would not stop enterprising designers from producing pumps and equipment for still higher pressure if they knew that, when proved successful, these designs could be rendered marketable by the official raising of the standard pressure. This standardisation and the ability to accommodate a relatively large engine driven generator would do much to simplify the present position with regard to hydraulics.

It might be convenient here to review the possibilities of future development in hydraulic systems. Standardisation comes first and here little further comment is necessary. The necessity for higher pressures comes next, the obvious advantages being the reduction in size of jacks, pipe lines, reservoirs, etc., and in the amount of oil carried. Another point requiring attention is the method of achieving the commencement and cessation of oil flow under pressure. In most cases it is desirable, and in some cases essential, that energy should be available for immediate operation without any time lag. In other words, it is desirable that running through the aircraft there should be a hydraulic main, which is always maintained slightly above the working pressure. The pumps in general use to-day are of the constant displacement type and must therefore be circulating free oil at all times when not actually engaged in the operation of some mechanism. To retain a pressure on the delivery side of the pump by a blow-off valve is not possible owing to the disastrous heating of the oil which would result. A large diameter pipe for the free oil circuit is therefore essential with this type of pump, a two-way valve, either manually or automatically operated, being inserted in this circuit to provide for the diverting of the oil into the working circuits when required. Although of no great disadvantage in single-engined aircraft, in multi-engined aircraft this consideration involves the duplication of two-way valves or the use of undesirably long large diameter pipe lines. All this can be overcome by employing a self-regulating pump working on the variable stroke principle and I am interested to learn that such a pump has been satisfactorily produced. With a pump of this type it can be coupled directly to the hydraulic main and, at such time as no oil is required, the pump delivery is nil, but a pressure slightly above the working pressure is retained in the pipe line.

No doubt some will consider that the maintaining of pressure in the main, particularly at the higher pressures contemplated, may give rise to trouble with regard to external leaks. I do not think this is necessarily the case and I suggest this can be overcome by careful design.

Generally speaking, it is only the pipe line and control valve which are continuously subject to these pressures. The provision of an oil tight pipe coupling presents no great difficulty and leaks in the control assemblies should give no trouble if it is arranged that all high pressure leaks pass into the low pressure return side and that, where spindles and so forth pass out of the casing, the possible leaks at these points are subject to low pressure return oil only.

(11) Emergency Operation.

I mentioned earlier in the paper that there were many specific examples of the virtues of hydraulics in comparison with electricity. One such example which I am sure would be raised in the discussion if I did not refer to it here, is the question of emergency operation in the event of the failure of a service, or at least its source of energy. The pneumatically loaded hydraulic accumulator provides a very ready solution, but if this is not considered a genuine independent alternative, it is a comparatively simple matter in a hydraulic system to arrange a cylinder of compressed gas, such as air or CO_2, to provide the necessary motive power for a jack. As the size of this cylinder is dependent only upon the amount of energy it stores, and not upon the horse-power required, it can be extremely light when the duration of functioning is short, which is, of course, the case with most of the operations where emergency measures are called for. To obtain a similar result by storage batteries in an electrical circuit, where the power required might be two or three horse-power, would involve prohibitive weight even assuming gross overloading of the battery for the short period. Moreover, the storage battery is no more a genuine alternative for the electrical service than is the hydraulic accumulator for the hydraulic service. In addition we have manually operated mechanical emergency operation which limits the horse-power to a fractional amount and is therefore not permissible when the emergency measures necessitate high speed of operation. Where the work to be done permits of leisurely or protracted fulfilment, manual operation is of course quite satisfactory.

(12) Final Summary.

This brings me to the end of these notes, but I would like to summarise the conclusions and proposals contained in them. Briefly it is suggested:—

To retain electricity and hydraulics only.

To drive the generators for these two services off the main power unit or units.

To standardise a pressure for the hydraulic service, this pressure to be as high as is practicable.

To retain direct current at 24 volts for the electrical service.

To adopt, as an interim measure, the generation of pneumatic energy, where necessary, by a small electrically driven pump unit, until such time as new equipment becomes available.

May I here express thanks and appreciation to friends and colleagues, in both my own and other firms, for the assistance they have rendered me in discussing certain aspects of this paper, and in some cases providing me with data. I feel I should say also that the views expressed in these notes are personal ones and not necessarily those of my firm.

In conclusion, I would like to repeat that one of the purposes of Mr. Nixon's and my paper is to promote a fertile discussion, and with this end in view, may I be permitted to ask those who are about to criticise—and I hope there are many—to temper those criticisms with constructive suggestions for practical alternatives where possible.

Part II.

The Engine Viewpoint.

By F. Nixon.

Introduction.

The problem under discussion is one which concerns both aircraft and engine constructors to an equal degree. Yet although their interest in it is a common one, inevitably their viewpoints will be different. This is not to say, however, that their conclusions will clash, and I want to make it clear that in setting out my views, as those of an engine designer, I intend them to be complementary to those of Mr. Chaplin, with the hope that taken together, they will in some measure help in leading towards a complete solution of the problem.

Mr. Chaplin has reviewed the difficulties as they appear to-day. He has laid down the desiderata for the ideal comprehensive power service, and he has made

Fig. 1.

Rear view of Pegasus engine without accessories.

a plea for simplification and standardisation. After considering the merits of various types of power, constructive suggestions have been put forward.

Up to the present engine manufacturers have been concerned primarily with the provision of mountings and drives for the power units called for by aircraft constructors. It was realised that there was by no means a uniformity of ideas, and in preparing this paper it has been necessary to go much more deeply into the basic problems. In this I have been greatly assisted by accessory firms, in this country and in France, Germany, and the United States, and the extremely

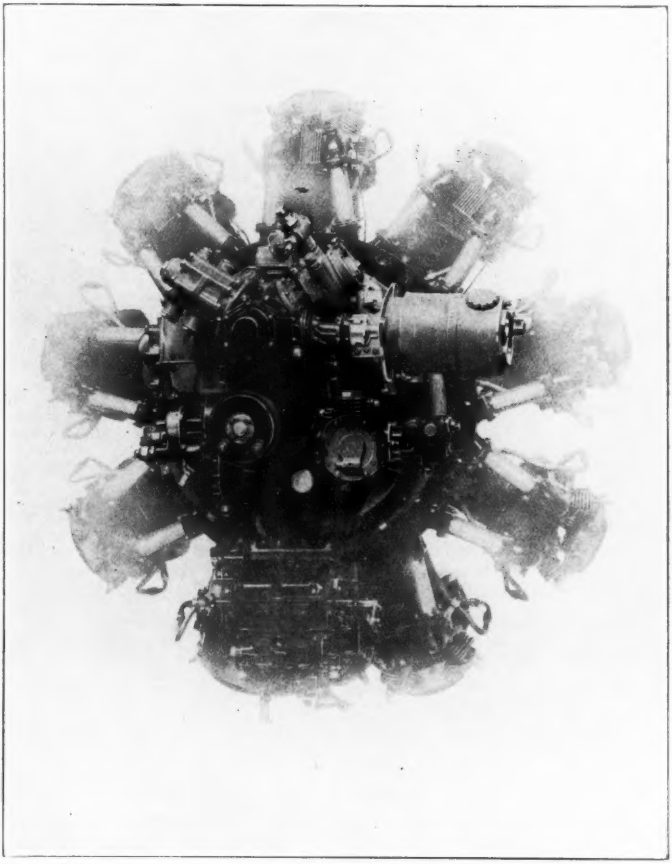

FIG. 2.

Rear view of Pegasus engine with generator, constant speed airscrew control, vacuum pump, twin hydraulic pump and air compressor.

generous response to requests for information and views has indicated that the firms concerned are themselves anxious to arrive at a satisfactory solution. So many opposing views have been put forward by the protagonists of the different forms of power service that in an effort to bring some order to the problem I have put in tabular form some of the factors involved. Two tables have been prepared. They appear in Appendix II.

In order to deal adequately with that aspect of the problem which most closely concerns the engine designer, namely, the provision of power, it will be necessary first to review the circumstances out of which the present situation has arisen.

THE DEVELOPMENT OF THE NEED FOR ANCILLARY POWER.

Originally power was required only for gun operation, starting, wireless telegraphy, lighting, and later brakes. Compressed air and electricity obtained from an engine-driven generator, and stored in batteries, were the sources used.

Compressed air was the obvious choice for non-electric power, as with it power can be bottled and carried about. Later an air compressor was driven by the engine for charging the bottle, and in some cases the compressor was also used as an air motor for engine starting. The engine therefore had to provide, in addition to the drives for magnetos, oil pumps, gun synchronising gear and tachometer, two ancillary drives, one for a generator, usually of 500-watt output, and one for an air compressor.

About four years ago it became evident that with the increased adoption of retractable undercarriages, wing flaps, and gun turrets, much more power would be required, and an effort was made to find out what would be needed. This had no immediate result, and, together with an expansion programme, engine makers found themselves suddenly faced with ever increasing demands for more power. In the time available, with engine types already crystallised and in production, the only solution was to add one drive after another for the hydraulic pumps, air compressors, and vacuum pumps as they came along. Figs. 1 and 2 show the sort of Christmas tree the Pegasus engine became in the period from 1935 to 1937.

When servo power became necessary for retracting undercarriages and rotating gun turrets, hydraulic power was the obvious solution. There was insufficient electrical energy available on most installations, and in any case at the voltages obtaining its use would have entailed a great deal of weight. It was felt that anybody could design an oil pump and a hydraulic jack. Anybody could, and did, with the result that at the end of a year there existed a medley of ideas as to what constituted the best as regards oil pressures and powers required. The results of this hasty conception remain, as will be seen from the varied operating pressures of the pumps listed in Appendix III. While the rapidity with which solutions had to be found is some excuse, it is felt that the opportunity to rationalise the whole of the servo and power systems on aircraft was missed by firms specialising in hydraulics. Although excellent results have been achieved in certain well-known instances, the under-developed state of many hydraulic systems has given impetus to a movement towards all-electric power.

Aircraft manufacturers, reacting from the multiplicity of different services now existing, are being attracted towards the idea of a centrally-located auxiliary power unit.

FORMS OF ANCILLARY POWER.

The three basic forms of power, namely:—

(1) Pneumatic—high and low pressure and vacuum,
(2) Hydraulic,
(3) Electric,

have already been discussed in some detail by Mr. Chaplin, and the suggestion has been put forward that the use of hydraulic and electric power should be extended to supersede compressed air and vacuum.

From the point of view of drive, installation, stores, and servicing, such simplification would be equally attractive both to aircraft and engine constructors. Manufacturers of air compressors and vacuum pumps, and of the services they operate, may have other views, however, and it is hoped that these will be ventilated in the discussion.

The merits and demerits of the various forms of power have already been dealt with as they affect the aircraft constructor, but as the production of power and the agents adopted for its application are inter-related, it is thought desirable to make a brief survey from the engine designer's point of view.

Purely mechanical applications—to undercarriage retraction for example—have not been considered since their standardisation for all types of aircraft is not thought to be feasible.

(1) Pneumatic Power.

Using compressed air, the working fluid costs nothing and can be obtained anywhere. The compressors are reasonably light for their output, and no return pipes are necessary. Compressed air is convenient for machine gun operation, as very small quantities are needed, and sufficient air for several flights can be stored in a high pressure bottle, the air pressure being reduced for the service required.

Against the use of compressed air is the difficulty of observing and preventing leaks. The compressor must be made oversize to have sufficient capacity at altitude, and the cylinder containing air at high pressure is rather vulnerable. A serious disadvantage is the delay which occurs through the compressibility of air. With dependence upon brakes as part of the landing technique, immediate response is essential, and this cannot be obtained with air operation. Undercarriage operation requires higher pressures than are at present available, and in any case, the experience of recent years has not been such as to inspire one with confidence that higher pressures are possible, although there is no fundamental reason why satisfactory air compressors could not be developed.

On the balance, it appears that there is no scope for compressed air for brakes and undercarriage. It might be retained for guns and the automatic pilot, were it not for the desire for simplification. There remains the operation of instruments by vacuum and the inflation of the pneumatic wing de-icer by low pressure air. These two services are well established, and if the wing de-icer maintains its position against the "Anticer" and "Kilfrost" schemes, then the continuance of the use of vacuum for instruments will also be justified, since the same pump can operate both services.

(2) Hydraulic Power.

A strong case can be made for the use of hydraulic power wherever possible. The pumps and motors are light for their output, specific weights as low as 2 lbs./h.p. being common, and transmission pipes can be installed easily. Jacks provide a convenient means of applying the power to undercarriage, flaps, and bomb doors, and they can moreover be embodied in structural members. In the case of gun turrets, the hydraulic system is ideal, providing that precise control which is necessary, without involving heavy, complicated and inefficient gearing.

Hydraulic power is reliable and comparatively cheap, while duplication for emergency operation can easily be provided by compressed air or CO_2, or by a hand-operated pump. If an overload is imposed a blow-off valve comes into operation and the system cuts out until the load is removed. There are no fuses to be replaced before operation can be resumed. The drive for the pumps can be arranged easily, as it is usually at engine speed. There is no risk of fire, and altitude has no effect on the power output.

The scaling-up of the hydraulic equipment as bigger aircraft are designed is a simple matter, involving only bigger rams for bigger loads, and bigger pumps for reduced time of retraction. Hydraulic equipment requires only mechanical knowledge on the part of the maintenance staff.

Its critics base their chief objections on the weight of piping necessary and the complications of cocks, valves and blow-off relief valves. The pipe line is vulnerable, and it cannot be duplicated easily, while should a pipe be broken the whole hydraulic system would cut out.

The weight of pipe line and equipment can be appreciably reduced by increasing the operating pressure. The greater tendency to leak, the need for strengthening parts, and the fact that minimum jack size is dictated by structural reasons, however, give a diminishing return in weight-saving as pressures are increased. It has been estimated that doubling the pressure would give a weight saving of about 20 per cent.

As will be seen from the data given in Appendix III, a big variation in operating pressures exists. There is some difference of opinion as to the optimum pressure for undercarriages, and experience alone will give this, but it is probable that it will be established at about 3,000lb./sq. in. For gun turrets, unless the power required increases, pressures of this order would be a disadvantage because of the difficulty of metering small quantities of oil. Although it is felt that there will be some increase beyond the present value of 300lb./sq. in., the pressure used for undercarriages and flaps is not likely to be reached, and so a separate system for the gun turrets will be necessary.

(3) Electric Power.

Electric power is essential for some purposes. To an extent depending upon the size of machine, electricity is used for wireless, cabin and navigation lights, heating of venturis and perhaps the crew's clothing, and heating of food. In most cases it is used also for starting, and it does in fact provide the only means of obtaining an unlimited number of starts from the cockpit.

The use of electricity for power services other than those mentioned has not yet developed to any great extent, owing to the weight of cable, batteries, and motors, and the necessity for gearing, which is both heavy and inefficient. The generator and motor are not quite as reliable as their hydraulic equivalents, and duplication cannot be provided except by mechanical means or by having two motors. On the other hand, it is a simple matter to run the wires in parallel and the effect of a break is to put out of commission only one service, and not the whole system. Perhaps the biggest advantage is the convenience of distribution and control, and this has led to the suggestion that hydraulic services which are remote from the engine should be energised electrically.

It is claimed that most of the drawbacks attaching to the use of electricity would be avoided by the adoption of high voltage alternating current—110 volts, 3-phase, 800 cycle has been proposed—which would greatly reduce the weight of cable and alternators and motors, and obviate the necessity for a heavy battery. Mr. Chaplin has dealt with the various aspects of high and low voltage, D.C. and A.C. supply. This question is one on which there are conflicting opinions, and it is of particular interest since it has a great influence upon the form which the basic supply of power will take. Should low voltage current persist, it is felt that the use of electricity would only develop to a limited extent, in which case the provision of power would require different treatment from that which would be necessary were high voltage current an established actuality.

The Basic Source of Power.

The main concern of the engine constructor is the quantity of power required, and the way in which he can best provide that power. A surprisingly large amount is required on modern aircraft, particularly those intended for military use. We can compile a list of services as long as that in Appendix I and even then be uncertain that it is complete.

On a twin-engined bomber of 20,000lbs. all-up weight, a total of about 12 h.p. must be available, while a machine of 60,000lbs. all-up weight requires a total of about 30 h.p., with a maximum instantaneous demand of about 12 h.p. These last figures show that a good load factor could be achieved if all the power were applied in the same way. In actual fact, with the employment in the same aeroplane of electric, hydraulic and pneumatic services, it is unfortunate that the load factors of the individual systems are uneconomically low.

Two possible sources of power are available, the main engines themselves, and a small auxiliary. Either alternative must be reliable, light, easy to install, and of reasonably low cost.

(1) The Main Engines.

We have already seen how the rear cover of the engine has become overloaded with a multitude of accessories. Although a reduction in the number of different units to be driven is urgently required, it is felt that such simplification will not come along immediately, and for a time at least it is certain that we shall have to make provision for a large number of different types. Taking as a typical example a twin-engined bomber, having three turrets, the following units may be called for (see Fig. 3):—

One 1,000-watt generator.
Two hydraulic pumps for undercarriage, flaps and bomb doors.
Three hydraulic pumps for the turrets.
One high pressure air compressor for brakes and guns.
One low pressure air compressor for automatic pilot.
One vacuum pump for instruments.
Two constant speed airscrew controls.

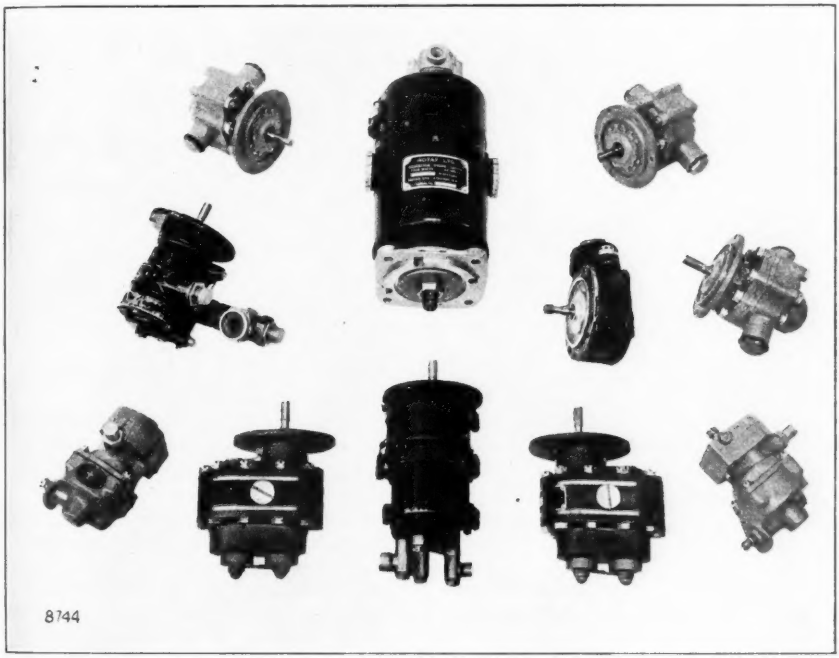

Fig. 3.

Accessories for twin-engined bomber.

Eleven units provide quite a good argument for duplication of the engines! On current engines it has been necessary to provide adaptors to accommodate the different driving pads and shafts, and in some cases we have had to take off two drives where previously there had been one. In face of these difficulties

the Gnome Rhone Company has gone so far as to design a starter carrying drives for two accessories. On their part, pump manufacturers have assisted by providing two pumps in tandem in one unit.

A recent development has been the provision of a gearbox driven from the engine by means of a cardan shaft. This, while retaining the advantages of main engine drive, takes from the engine constructor the onus of providing drives in the combinations required by different installations. As the gearbox is capable of driving simultaneously any four or any six of the accessories existing to-day, the engine constructor has been able to clean up his design considerably, and at the same time to develop and produce engines without reference to their ultimate destination. With direct-mounted accessories it is a difficult matter to correlate the requirements of different aircraft and to maintain rates of production appropriate to them.

The accessory gearbox facilitates installation considerably. It can be mounted, with its accessories, on the bulkhead, so that the pipe lines can be shortened, and main engines can be removed for overhaul without disturbing the accessories and their pipes. Moreover, accessory drive speeds can be standardised, for the gearbox can be run at the same speed whatever the speed of the engine.

In comparison with the auxiliary power unit, main engine drive, whether direct or through a gearbox, has the very important advantages of minimum weight and maximum reliability through duplication. Insistence is made on multiplication of engines for safety, and extending this to the essential ancillary services, there is no doubt that the main engine drive gives the lightest and cheapest solution. The drive, too, is compensated for altitude by the main engine supercharger.

On the other hand, main engine drive means complication of the nacelle layout, and it suffers from the inability to provide, at the present, other than direct current. In order to have a store of energy for emergency running on the ground, and for starting, it is necessary to carry accumulators.

Main engine drive could, however, be used for the generation of alternating current by embodying a variable speed drive controlled by a governor to keep the alternator speed constant at a value equivalent to the gliding speed of the engine. Unfortunately a large proportion of the total power required on an aeroplane is called for a gliding speed, *e.g.*, wireless, undercarriage, lighting and heating, nevertheless it is thought that a system could be evolved, using either a mechanical variable speed transmission, or rather paradoxically a hydraulic variable speed pump and motor between the engine and the alternator, which would compete on a weight basis with the auxiliary power unit. This latter scheme has the advantage of greater flexibility of installation.

Taking as the output required from each engine, 3 kilowatts, which would give sufficient current from four engines for the very largest machines, and assuming an overall efficiency of 60 per cent., the input horse-power at the engine would be 5 kw., or 6.7 h.p.

The oil pump driven by the engine would, therefore, have to have a maximum output of 6.7 h.p., at say 1,000 r.p.m. At higher speeds its delivery would be reduced and it would not be working at its maximum capacity. Its specific weight on the basis of power output at 1,000 r.p.m. would therefore be high, say 4lbs. per h.p., or a total weight of 26.8lbs.

The hydraulic motor, on the other hand, would be running at constant speed, and it could be designed for maximum efficiency at its running speed. Its weight would therefore be about 6.7×90 per cent. $\times 2 = 12.0$lbs.

The alternator would weigh about 10lbs. per kilowatt, say 30lbs., and assuming 4lbs. for the governor and allowing 10 per cent. for the pipes and mounting, the total weight of the installation would be 80lbs., or 26.6lbs. per kw.

This last weight compares very favourably with that of the other methods of generation of electricity and while installation would be a difficult problem, the hydraulic motor and the alternator could be housed within the wing or the nacelle.

With this system it would be necessary to have some means of starting the engines, and of providing current for wireless and lighting when on the ground. On small machines, say up to 10,000lbs. all-up weight, starting could be effected with the cartridge starter, since the limited capacity of the breech is not a drawback here. For emergency wireless a small battery could be carried, charged through a transformer and rectifier from the alternators.

On larger machines a small auxiliary engine of about 2 or 3 kw. capacity would be justified. In this way it would be possible to standardise high voltage A.C. on all sizes of machine, and to employ it more extensively and more economically than is possible with D.C.

(2) The Auxiliary Power Unit.

The first auxiliary power unit was probably used to drive an air compressor for starting, and was adopted in order to simplify installation and control of the compressor, which was needed only when the air bottle required charging.

The centralisation of all the accessories on a small auxiliary engine is most attractive at first sight, but the proposal must be examined more closely. The first argument in favour of the scheme is the simplification of the engine installation, permitting more rapid changing of engines, and the reduction in length of wiring and piping necessary. Power is available on the ground, for starting, lighting, and for the emergency operation of wireless, so that batteries can be dispensed with. Moreover, the auxiliary engine provides a constant speed drive for an alternator, permitting the generation of high voltage alternating current, and giving a considerable saving in weight of the electrical equipment.

On the other hand, the central power unit suffers from the disadvantages of weight and difficulty of installation. The extent to which power is used on aircraft has increased considerably, and it is now essential that certain of the services should be maintained without interruption, at all altitudes. Hence the donkey engines must be duplicated and they must be compensated for altitude, either by supercharging or by being made oversize. Present practice is to adopt the latter expedient for cheapness, and the result is a rather heavy power plant. The installation of the units also involves considerable weight. They must be located centrally for convenience and servicing during flight, which means that they will be adjacent to the cabin. It is necessary, therefore, to have them in fire and noise-proof compartments, which must at the same time allow of adequate cooling and accessibility.

It is obvious that the centralisation of all the accessories on an auxiliary engine can only be realised on large aircraft, and even then the size and weight will be serious drawbacks. From the point of view of standardisation it is a disadvantage to have to change from one method (*i.e.*, main engine drive) to another (auxiliary power unit drive) when a certain size of machine is reached.

So far it has been assumed that these auxiliary units will be used for driving all the accessories. A much better case can be made for them if they are used in a subsidiary capacity only, in conjunction with main engine drive. By driving the bulk of the accessories from the main engine, and using the auxiliary engine only for those units required for starting and ground operation, such as wireless and emergency lighting, the engine could be reduced considerably in size and weight. Not only would the power required be much less, but the engine would no longer need to be oversize, and since servicing and repair would be possible, duplication would not be necessary.

This scheme would be applicable to all types of power, whether hydraulic or electric, D.C. or A.C. The main engine drives would be used for the hydraulic pumps and for the main electrical generators for either direct or alternating current. The small auxiliary power unit would not need to be of more than 3 or 4 kilowatt output even for the biggest machines. It would supply all the current required for starting, wireless and emergency lighting. If alternating

current were adopted, it should be possible to produce 3 kilowatts for a total weight of about 75lbs., or 25lbs. per kilowatt.

In Appendix V brief descriptions of a few representative types of available power groups have been given.

SOME CONCLUSIONS.

The first step in providing a solution to the problem before us is to reduce the number of different types of power to a minimum. Standardisation of accessory drives and mountings goes without saying, and this aspect is receiving attention at the present time.

The kind of power used for the mechanical work in a particular aeroplane will depend upon the size and type of the machine, and the other services required. It can be taken as axiomatic that, *for maximum economy, if a particular kind of power must be used for a certain service, then other uses should be found for it in order to bring the load factor up to the maximum value possible.*

This point is extremely important and cannot be over-emphasised. Load factors of some of the services are extremely low. For instance, to start an engine requires 3.6 kw. for 3 seconds. To raise the undercarriage of a large machine electrically calls for 4.8 kw. for 50 seconds, while the whole of the continuous services, including wireless and lighting of a large passenger cabin, requires only about 2 kw.

With large aircraft, and particularly in the case of civil machines, a great deal of electricity is needed (for lighting, wireless and cooking). Here it is probable that the electrical energy already available will be extended to the retraction of the undercarriage, wing flaps, bomb doors, and remote drive for turret pumps, offering a saving in weight, or greater convenience, over a hydraulic system, particularly if an A.C. supply is available.

Operation of brakes is best effected by hydraulic means, but the pump providing the oil is used only during take-off and landing, so that other uses should be found for this pressure oil during flight. We may have, therefore, hydraulic power applied to undercarriages, gun turrets, flaps, and bomb doors, to a greater or lesser degree, and electricity, in addition to starting, wireless, and lighting, may also be applied to some or all of these duties to a varying extent depending upon the purpose of the aeroplane.

I would suggest that in the near future we shall see compressed air replaced by oil, and oil pressures standardised at two values, say 3,000lbs./sq. in. for brakes and jacks, and about 1,000lbs./sq. in. for gun turrets. Vacuum for instruments, and low pressure air for wing de-icers, may be retained, but this will depend upon developments in these two groups. Electricity is well established, and its application is likely to be extended. I do not feel qualified to express an opinion on the relative merits of D.C. and A.C., but should the claims of those experts who point to the reduction in weight, the freedom from sparking, and the ease of conversion given by A.C. be borne out, then I see no particular difficulty in providing drives for the generation of this current. Whichever current is finally adopted, however, it is important to insist on its standardisation on all aircraft.

Assuming for the moment that the use of high voltage alternating current is justified, it does not seem likely that it will be widely adopted for military aircraft until some satisfactory means has been developed for driving alternators from the main engine. This would not only reduce the weight of generation appreciably, but it would also allow of standardisation of instruments and equipment throughout a wide range of aircraft sizes. For the present, bearing in mind the time taken to establish a new development, it appears likely that 24-volt D.C. will persist. For the future, it is suggested that a thorough review of the merits of 24-volt D.C., 24-volt A.C., and 110-volt A.C., be made before embarking on a programme of development, in order to avoid a repetition of the experience with hydraulic systems.

It is the manufacturers of large aircraft who should be most favourably disposed to an extension of the application of electricity and the makers of smaller high speed machines who should favour hydraulics. It is felt that while it is impossible to dogmatise, and while each case must be considered on its individual merits, this generalisation will be sound.

The concentration of all the accessories in a central group is not thought to be expedient. Duplication is essential for safety, and the installation of the auxiliary power unit introduces difficult problems such as sound-proofing, which are particularly important in civil aircraft. The system is, moreover, unduly large and weighty. For instance, the production of 13 kw. on the Douglas DC. 4 requires a total weight of 647lbs., involving as it does duplication of the auxiliary units and running throttled on the ground.

With the development of accessory gearboxes, and quickly detachable power eggs, many of the objections to main engine drive disappear. For the immediate future, it is suggested that the solution lies in the use of standardised oil pressures, and 24-volt direct current, the oil pumps and generators being mounted on accessory gearboxes. Vacuum pumps will have to be retained for the present.

Possibly the ideal solution is a constant speed hydraulic drive enabling an alternator to be driven from the main engine, together with a small auxiliary engine-alternator group. In the beginning a unit capacity of 2 kilowatts would probably be sufficient, this being increased to 3 kilowatts for bigger aircraft. It would thus be possible to have available 4 kilowatts on a twin-engined machine, with 2 kilowatts with one engine cut out, and 2 kilowatts on the ground from the auxiliary unit. On large machines, with four engines, a total of 12 kilowatts should be adequate during flight, and 3 kilowatts for emergency on the ground, for a total weight of about 395lbs.

This scheme would extend the use of alternating current down to a much smaller size of machine than could accommodate the central power group. For machines below this size, it would be possible to utilise alternating current by employing a battery solely for starting and emergency wireless, the battery being charged by the alternators through a transformer and rectifier. Although it is realised that this scheme would still involve heavy cables between battery and starters, it would be possible to use A.C. instruments and motors and thus permit standardisation of this equipment for all sizes of machine. Alternatively, the use of the cartridge starter would permit of a reduction in size of the battery, which would then be required only for emergency wireless. Nor must we overlook the possibilities of starting by hydraulic means.

The solution of the problem on rational lines is largely in the hands of the manufacturers of accessories. It is hoped that the views which we have put forward will have been of service as indicating the many aspects which have to be considered.

ACKNOWLEDGMENT.

Grateful acknowledgment is made to the members of aircraft firms, and to the manufacturers of accessories, who have so generously supplied information and suggestions.

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For other papers on the subject see :—

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Appendix I.

List of Power Services on Aircraft.

The following is a list of the services which are or may be operated by power. It is not necessarily complete.

Engine.	Airscrew.	Aircraft.	
		General.	Military
Starting.	Constant speed unit.	Undercarriage.	Machine guns.
Cooling—radiator shutter.	Feathering booster pump.	Flaps.	Cannons.
cowling gill.	Brake.	Brakes.	Camera guns.
oil cooler shutter.	Pitch indicator.	Slots.	Gun turrets.
Fuel pump.		Flying controls.	Bomb doors.
Tachometer.		Automatic pilot.	Bomb release.
Synchroniser.		Wireless.	
Controls.		Cabin signals (internal telephone).	
		Fuel pump—for tank transfer.	
		for re-fuelling.	
		Re-fuelling pipe winch.	
		Lighting—cabin, landing (searchlight), navigational, anchor.	
		Heating—cabin, venturis, crew's clothing, food.	
		Fire extinguisher.	
		Airscrew and wing de-icing.	
		Instruments.	
		Sirens.	
		Water rudder.	
		Bilge pump.	
		Anchor winch.	
		Cabin supercharging.	

Appendix II.

Basic Source of Power.

Main Engine Drive.

Factor	Direct	Accessory Gear Box	Auxiliary Power Unit
1. Reliability.	Good.	Good.	Good.
2. Weight.	Light.	Light.	Heavy.
3. Installation.	Complicates power unit.	Fairly simple, except in small machines.	Central, but requires silent chamber. Impossible for small machines.
4. Maintenance on ground.	Troublesome. Interferes with engine servicing.	Moderately simple.	Simple.
5. Maintenance in flight.	Impossible.	Impossible.	Possible.
6. Duplication of services.	Inherently simple.	Inherently simple.	Very heavy.
7. Availability on ground.	Only with batteries, or compressed air.	Only with batteries, or compressed air.	Always available.
8. Compensation for altitude.	Inherent.	Inherent.	Necessitates supercharged or oversize unit.
9. Fire risk.	Small.	Small.	Considerable, chamber requires protection.
10. Noise.	Not increased.	Not increased.	Requires silencing.
11. Generation of alternating current.	Requires constant speed drive.	Requires constant speed drive.	Straightforward.

Forms of Ancillary Power.

Factor	Pneumatic.	Hydraulic.	Electric. D.C.	Electric. A.C.
1. Reliability.	Poor.	Good.	Good.	Good.
2. Weight.	Light.	Light.	Heavy.	Lighter than D.C.
3. Installation.	Simple. No return pipe required.	Simple, but two pipe lines required.	Simple. Cable size a drawback.	Simple.
4. Control.	Cocks and valves.	Cocks and valves.	Switches and solenoids.	Switches and solenoids.
5. Maintenance.	Difficult.	Simple.	Requires skilled personnel.	
6. Duplication (*a*) of source of energy.	By bottle.	By comp. air.	By battery.	Heavy.
(*b*) of transmission.	Difficult.	Difficult.	Easy.	Easy.
(*c*) of receiver.	Difficult.	Difficult.	Possible but heavy.	
7. Applicability to undercarriage, flaps, etc.	Not feasible with present pressures.	Ideal.	Very heavy.	Reasonably good.
8. Applicability to gun turrets.	Not feasible.	Ideal.	Not feasible except through hydraulic gearing.	
9. Vulnerability.	Pressure bottle dangerous.	Broken pipe involves complete shut down.	Low.	Low.
10. Availability on ground.	By compressed air bottle.	By compressed air accumulator.	By battery.	Requires auxiliary power unit.
11. Response.	Slow.	Rapid.	Instantaneous.	Instantaneous.

APPENDIX III.

HYDRAULIC PUMPS.

Manufacturer.	Type.	Model.	Purpose.	Pressure, lb./sq. inch. Normal	Pressure, lb./sq. inch. Blow off.	Delivery. Galls/hr.	Output. H.P.	Normal speed. R.P.M.	Weight. lbs.	Weight. ozs.
Integral Auxiliary Equipment Ltd.	Gear	B.H. Mark 2 / Mark 3	Turret and undercarriage	680		180	1.42	2,250	6	13
	Gear	B.H. Mark 4	Undercarriage and flaps	1,000 / 1,200		160 / 150	1.87 / 2.10	2,250	7	9
	Gear	B.H.C. Mark 1	Turret	600		360	2.28	2,250	8	0
	Gear	B.H.B. Mark 2	Undercarriage	800		360	2.90	2,250	8	0
	Gear	I.B.H. Mark 1	Turret and undercarriage	300 / 800	330	500 / 270	1.75 / 1.90	2,250	9	11
	Gear	I.H. Mark 1	Twin turret	300	330	1,000	3.50	2,250	8	11
	Gear	I.H.C.	Turret	300	330	650	2.11	2,250	7	3
	Gear	I.H.D.	Turret	300	330	540	1.80	2,250	6	3
Aircraft Components Ltd. (Dowty).	Gear	C.3589	Undercarriage	500 / 1,000	800	440 / 420	2.57 / 4.90	1,125	10	0
Pump Engineering Service Corporation. (Pesco).	Vane	196		200		168	0.39	2,250	3	7
	Gear	203	Undercarriage	800		155	1.45	2,250	3	12
(British Licensees: The Plessey Co. Ltd.)	Gear	203 DA.	Auto-Pilot	200		159	0.37	2,250	3	8
	Gear	204	Undercarriage	1,000		100	1.12	2,250	3	7
	Gear	214	Undercarriage	1,000		116	1.37	1,125	3	14
	Gear	247	Turret	1500 / 1400		500 / 585	2.84 / 2.74	2,250	8	9
Aviation Engineering (Messier) Co. Ltd.	Rotary radial	P.10	Undercarriage, flaps, etc.	1,400		54	0.88	2,250	5	8
	Rotary radial	P.12	,,	1,400		90	1.34	2,250	5	12
	Rotary radial	P.13	,,	1,500 / 2,250	1,750 / 2,500	130	2.22	3,000 Range 800-3,000	6	4
	Rotary radial	P.43 M	,,	1,400		120	1.92	2,250	6	9
	Rotary radial	52M2	,,	1,500 / 2,250	1,750 / 2,500	120	2.09	3,500 Range 1,000-3,750	6	12
	Rotary radial	53M3	,,	1,500 / 2,250	1,750 / 2,500	150	2.61	3,500 Range 1,000-3,750	7	0
Sperry Gyroscope Co.	Gear	8022	Auto-Pilot	200		210	0.49	2,250	4	4

Sperry Gyroscope Co. (Northern).	Gear	8029	Auto-Pilot	200		210	0.49	2,250	4	4
	Gear	P.L.1335	Auto-Pilot	200		150	0.35	2,100	4	0
Variable Speed Gear Ltd.	Swash-plate	0.4 (Mark 1)	Turret and under-carriage	1,000	1,200	440	5.10	2,250	14	8
	Swash-plate	0.22 (Mark 2)	Turret and under-carriage	1,000	1,200	460	5.37	2,250	11	0
Eclipse Aviation. (British Licensees: Rotax Ltd.)	Gerotor	M.3405	Undercarriage, floats, flaps	500		86	0.50	2,200	4	0
	Gerotor	M.3481	Undercarriage, floats, flaps	800		154	1.44	2,500	4	0
	Gerotor	B.1	Turret	300		300	1.04	2,250	5	8
Parnall Aircraft Ltd.	Vane	M-5D	Turret	300	350	960	3.36	2,250	8	13
	Vane	M-5S	Turret	300	350	495	1.75	2,250	6	12
	Vane	PS-Mark II	Turret	300		480	1.68	1,125	6	8
	Vane	PT-Mark I (MS-3D)	Turret	300		800	2.80	2,250	9	14
Automotive Products Co. Ltd. (Lockheed).	Rotary	Mark III	Undercarriage	850		2×32.5	0.65	1,300	9	4
	Rotary	Mark IV Series I	Undercarriage	950	1,600-1,650	65	0.66	1,300	9	13
	Rotary	Mark V Series I	Undercarriage	950	1,600-1,650	32.5	0.32	1,300	5	12
Vickers Aviation Co.	Opposed-twin	Mark III (A.990)	Undercarriage	{1,000 {1,600	1,600	60 60	0.70} 1.10}	1,125	5	5
	Opposed-twin	Mark III (A.1111)	Undercarriage	1,000	1,600	60	0.70	1,125	5	11
Tecalemit Ltd.	Rotary	B.3	Turret	500	550	576	3.33	1,200	8	2
	Rotary	B.4A	Turret	330	250	860	3.28	2,250	7	14
Societe pour l'Affranchi sement et le Timbrage Automatique (Olaer).	Swash-plate	11039	Undercarriage	3,200	3,900	26.4	0.97	2,250	2	2
British Metallic Packing Co. (1933) Ltd. (R.A.D.).	Reciprocating	Mark III	Undercarriage	1,000	1,250	150	1.77	2,250	10	11
Deboysson. (Air Equipment.) (Messier Licence.)		P.43M	Undercarriage	1,422		106 132	2.95	2,000 2,500	6	6

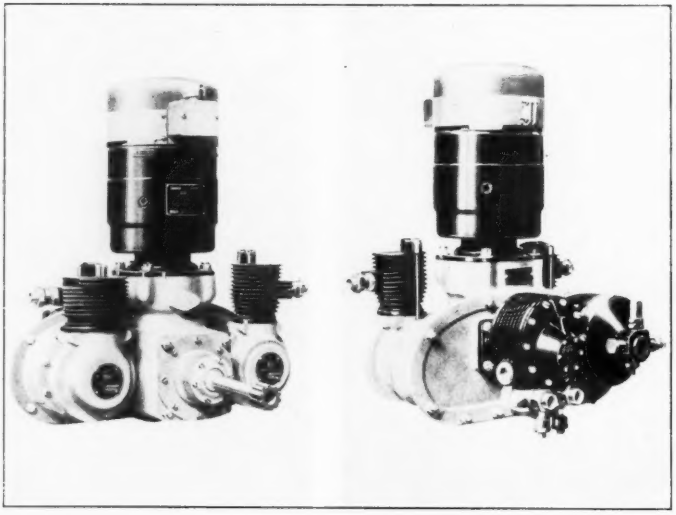
Appendix IV.

Accessory Gearboxes.

The past two years have seen the emergence of the accessory gearbox on a production basis. After a rather too ambitious start, notably in America, present types have become well established and are likely to remain a feature of installations for several years. The models described are not the only ones in use. Information regarding certain up-to-date types has not yet been released for publication.

(1) *The Air Equipment Gearbox* is shown in Fig. 4 driving five accessories:—

One 1,800-watt generator.
One vacuum pump.
One hydraulic pump.
One high pressure air compressor (420lbs./sq. in.).
One low pressure air compressor (35lbs./sq. in.).



Front. *Rear.*

Fig. 4.

The Air Equipment accessory gearbox.

It is driven through a cardan shaft at a normal speed of 2,500 r.p.m. An interesting feature is the incorporation of two slipping clutches of the multiple disc type, one in the main drive and one in the generator drive to prevent overloads. The lubrication system is self-contained.

(2) *The Armstrong Siddeley Gearbox*, illustrated in Fig. 5, shows the type used when only a small number of auxiliaries is required. This auxiliary box is designed for attachment either at the front or the rear of the fireproof bulkhead, and to be positioned at any angle round the centre line of the engine. Remote drive is obtained from the rear of the engine. Provision is made for retaining the oil level and receiving the exhaust from the vacuum pump.

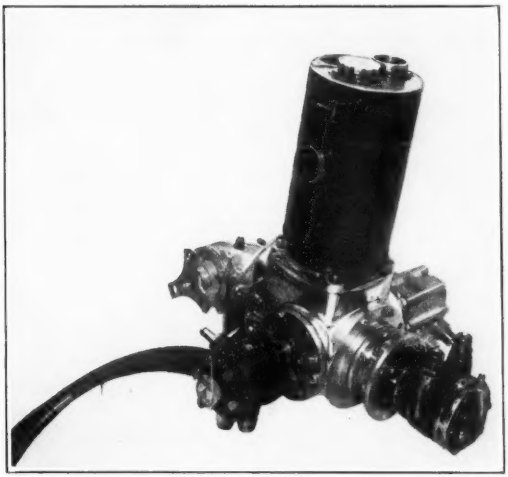


FIG. 5.
The Armstrong Siddeley accessory gearbox.

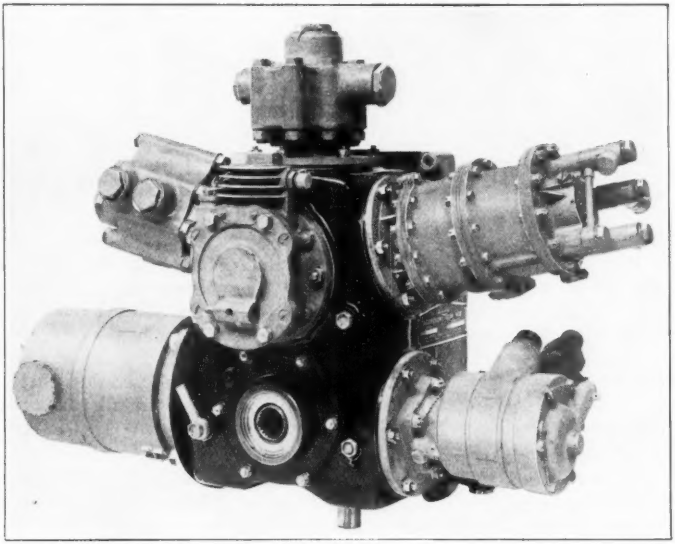


FIG. 6.
The Bristol six-unit accessory gearbox.

The following auxiliaries can be accommodated:—

B.T.H. A.V.A. compressor (high) ...	Any two.
R.A.E. compressor (low)	
Turret pump	
Lockheed fluid pump	
Northern oil pump	Any one.
Pesco vacuum pump	
Romec ,, ...	
Rotax ,, ...	

Weight (without auxiliaries) = 30lbs.

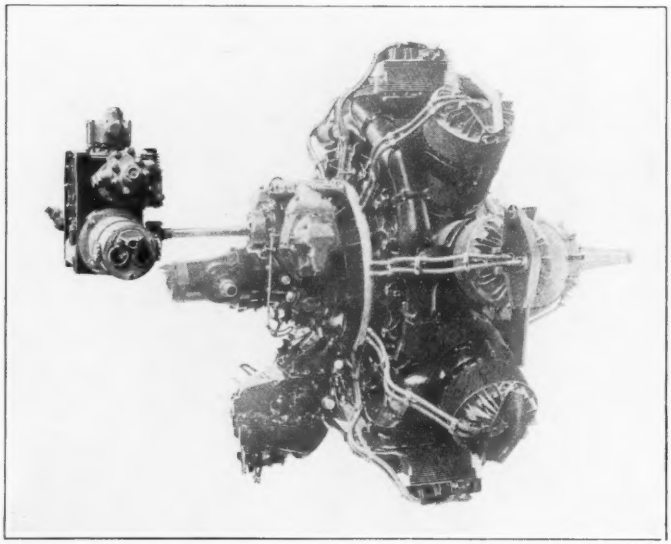


FIG. 7.
Perseus engine with six-unit gearbox.

(3) *The Bristol Aeroplane Company* has produced two basic types, one for four accessories, the other for six. The larger model weighs 24lbs., and has a total capacity of 30 h.p., the maximum power which may be taken from a single pad being 12 h.p. There is one high speed drive for the generator, three " engine speed " drives, and two " half engine speed " drives, while these can be modified if necessary by fitting adaptors. The main driving shaft embodies a needle roller bearing universal joint, and a rubber flexible joint of the Cardaflex type. A gear oil pump is embodied. Fig. 6 shows the gearbox, and Fig. 7 the gearbox coupled to an engine.

The four-unit gearbox weighs 15lbs., and exists in various forms, the generator being mounted either vertically or horizontally, whichever is more convenient.

(4) *The Gnome-Rhone Gearbox*, which is illustrated in Fig. 8, is interesting as being driven by a shaft passing through the engine starter. It provides seven driving pads, five of which are usually occupied by the 1,800-watt generator, the hydraulic pump, vacuum pump, and the high and low pressure air compressors. Total capacity is 20 h.p., and weight is 24lbs. Each of the seven drives incorporates a shear section. Lubrication is self-contained.

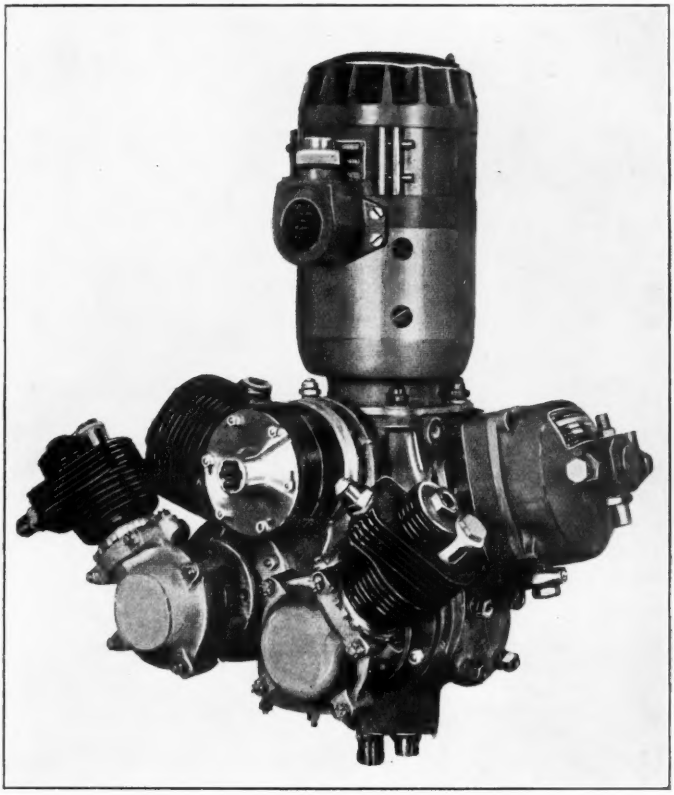


FIG. 8.
The Gnome-Rhone accessory gearbox.

APPENDIX V.

AUXILIARY POWER UNITS.

The great diversity of types of auxiliary power units which exist is evidence of the lack of agreed policy. In the main the auxiliary engines have each been designed for a specific purpose, and cannot be regarded as supplying the ideal solution.

It is proposed to give in this Appendix brief descriptions of some of the available units. The list is not necessarily a complete one, the types described having been taken as being representative of their class.

(1) *The A.B.C. Auxiliary Power Unit* is the most complete of existing units. Designed specially for use on large flying boats, it operates a 350-watt generator, a fuel pump capable of lifting 2,250 gallons an hour through 16 feet, a bilge pump delivering 2,500 gallons an hour with a lift of 16 feet, and two air compressors operating at 200lbs./sq. in. All of the accessories can be operated simultaneously, with the exception of the bilge pump, which requires the full output of the engine. When not required, the accessories are declutched from the main drive.

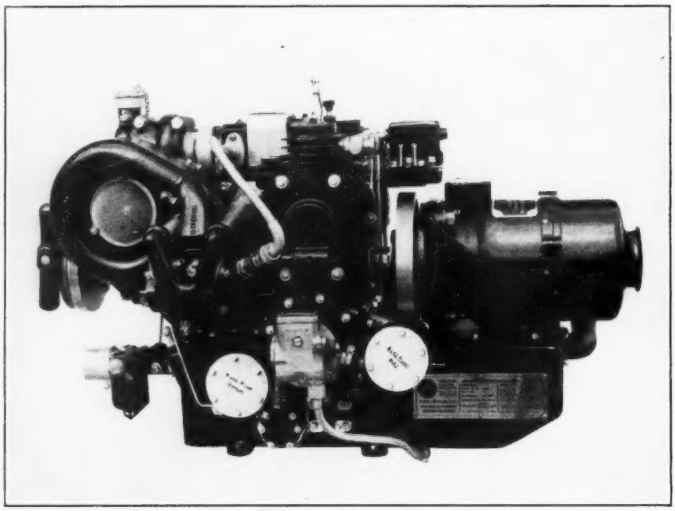


FIG. 9.
The A.B.C. auxiliary power unit.

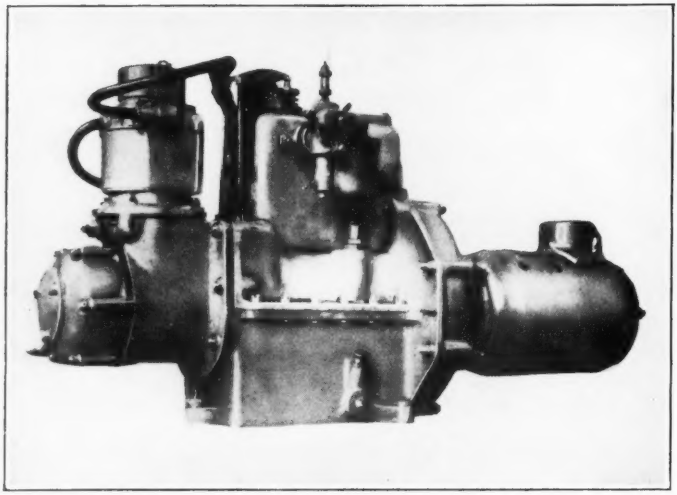


FIG. 10.
The Air Equipment engine compressor group.

The engine has two horizontally-opposed air-cooled cylinders of 54 mm. bore and 38 mm. stroke and gives a maximum output of 5 h.p. Duralumin and elektron are used extensively in its construction and the complete unit weighs only 140lbs. (Fig. 9).

(2) *The Air Equipment Engine—Compressor Group*, illustrated in Fig. 10, consists of a 4-cycle air-cooled single cylinder engine of 98 c.c. capacity, driving a single cylinder air compressor of 36 c.c. swept volume. There is a drive for a 600-watt generator, which can be used when the compressor is not under load, and a drive for a fuel transfer pump.

The engine has a ground level power of 2.6 b.h.p. at 4,500 r.p.m. The magneto can be used for starting the main engines, and with screened ignition and a built-in cooling fan, the whole, including engine and compressor, weighs 26lbs.

The compressor will charge a 732 cu. in. bottle to 426lbs./sq. inch in $4\frac{3}{4}$ minutes.

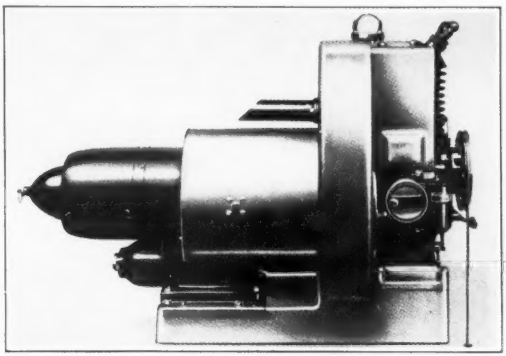


FIG. 11.

The Garelli Avio compressor with generator model RB.

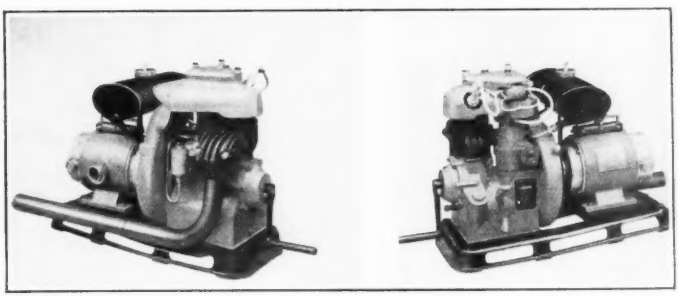


FIG. 12.

The Marconi-Stanley power unit.

(3) *The Eclipse Auxiliary Unit*, designed primarily for the Douglas DC. 4 machine, is the first unit intended to supply sufficient alternating current for all the needs of the aircraft.

It has obviously been well thought out. The engine has four horizontally opposed Prestone cooled cylinders of $2\frac{3}{4}$in. bore and 3in. stroke, and a total displacement of 72 cubic inches. It rotates at 4,000 r.p.m. and gives 30 h.p. on the ground. There is a centrifugal hydraulic governor holding the speed constant to within $\pm 2\frac{1}{2}$ per cent.

The weight of the engine, including hydraulic starter, magneto, mixture control, inlet air temperature control, fuel and oil pumps, coolant pump, flexible mounting, oil tank and gearbox is 231lbs.

Crankcase and cylinders are cast together in aluminium alloy, and the wet liner is in Ni resist cast iron. There are two valves driven by overhead camshaft through thimble tappets which enclose the valves and springs; copper-cooled stellited exhaust valves, and dual ignition. The coolant passes through a radiator through which air is drawn by an engine-driven fan. The carburettor air intake is provided with a thermostatically controlled heating device to prevent icing.

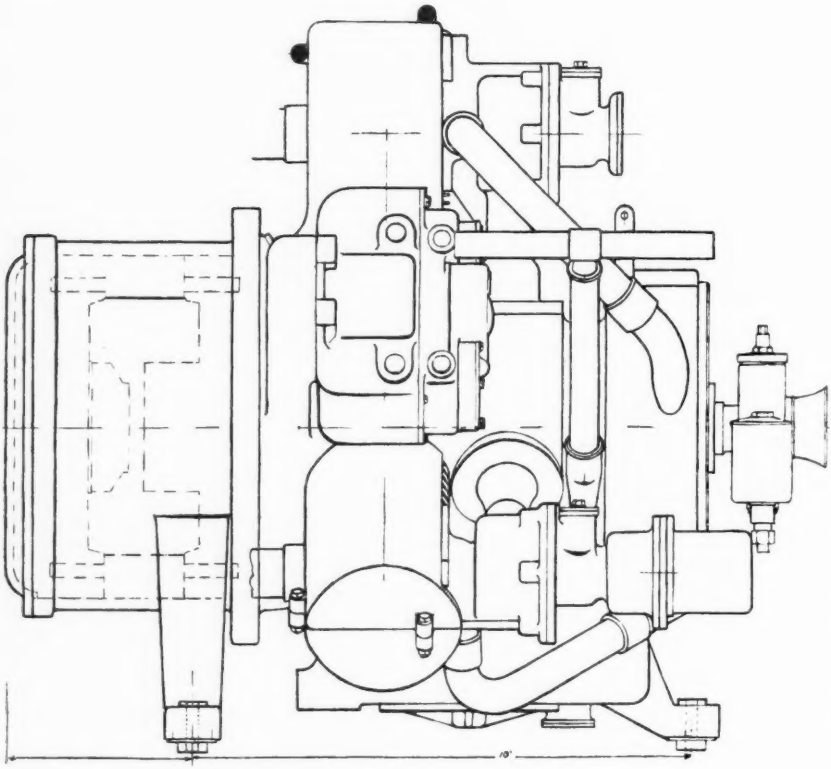


FIG. 13.

Rotax auxiliary engine.

Starting is by means of a gear pump and high pressure oil stored in a reservoir with a head of air.

This engine is used to drive a 6½ kw. alternator supplying 120-volt 800-cycle current, and weighing 62lbs. In addition there is a control unit weighing 4½lbs., and a compounding unit, condenser and resister assembly weighing 26lbs.

The DC. 4 carries two engines and two alternators, and in spite of the rather large weights involved the specific weight per kilowatt is 50lbs., based on maximum output.

(4) *The Garelli Motor Compressor*, designed primarily for compressed air starting, has been used extensively on the Continent. There are various models,

one of which is illustrated in Fig. 11. Basically there is a single two-stroke cylinder combined with a single cylinder compressor on the same crank and crankcase. Both are cooled by air from a flywheel fan. In certain models a generator can also be driven, through an elastic coupling.

All the models are capable of charging a bottle of 360 cubic inches capacity to 200lbs./sq. in. varying in time from 30 to 80 seconds, according to size. Weights vary from 17 to 40lbs.

When used in conjunction with a generator, the weight excluding generator is 31.7lbs. for the 400-watt size, and 45.2lbs. for the 700-watt size.

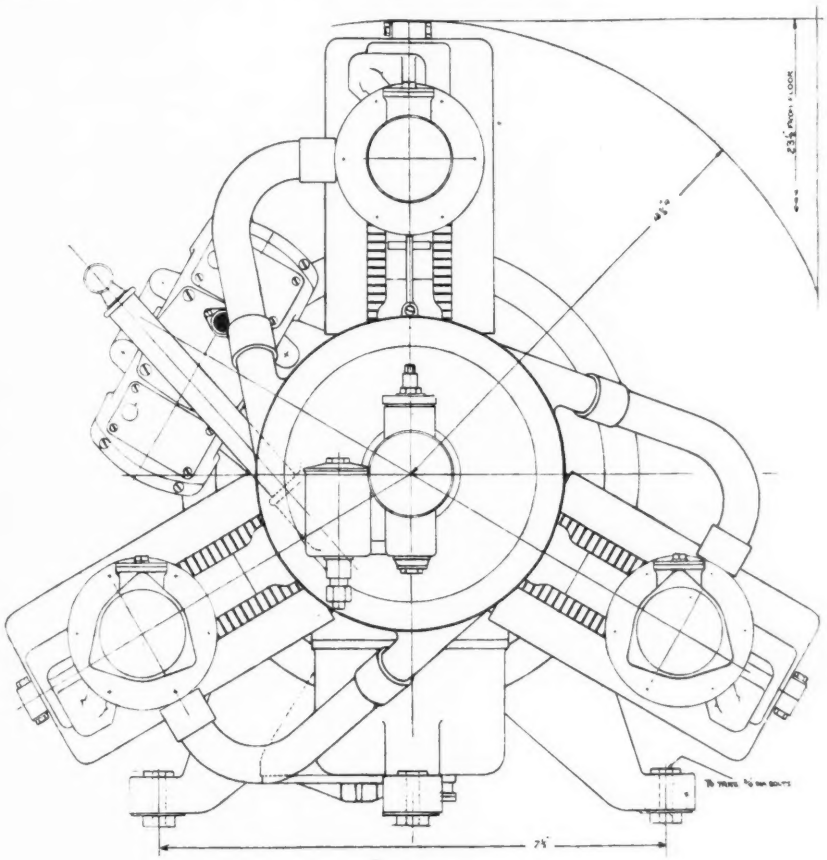


FIG. 13.

Rotax auxiliary engine.

(5) *The Marconi-Stanley Unit*, shown in Fig. 12, embodies a small air-cooled single cylinder two-stroke engine of 50 mm. bore and stroke and a capacity of 98 c.c. Nominal output is 1 h.p., but at the normal speed of 3,500 r.p.m., the maximum output is 2.1 b.h.p., and under normal conditions a continuous output of 1.6 b.h.p. can be maintained. The complete unit, which is used primarily for battery charging and wireless generator drive, comprises petrol tank, screened ignition, speed control, base plate, and flywheel with flexible coupling for driving a generator, and the weight is 34lbs. Starting is by hand crank.

(6) *The Rotax Alternator Unit*, which is under development, is an interesting auxiliary unit, details of which may now be released.

A three-cylinder radial air-cooled engine of 64 mm. bore and stroke and 618 c.c. capacity, develops a continuous output of 16.8 h.p. at altitude, and is used to drive a 10 kw. alternator. Figs. 13 and 14 show the installation and the alternator respectively.

The small engine runs at a normal speed of 6,000 r.p.m. and a compression ratio of 14 : 1, these being made possible by the Cross rotary valves of nitralloy which run in the Y alloy cylinders. Cooling air is provided by a fan driven by

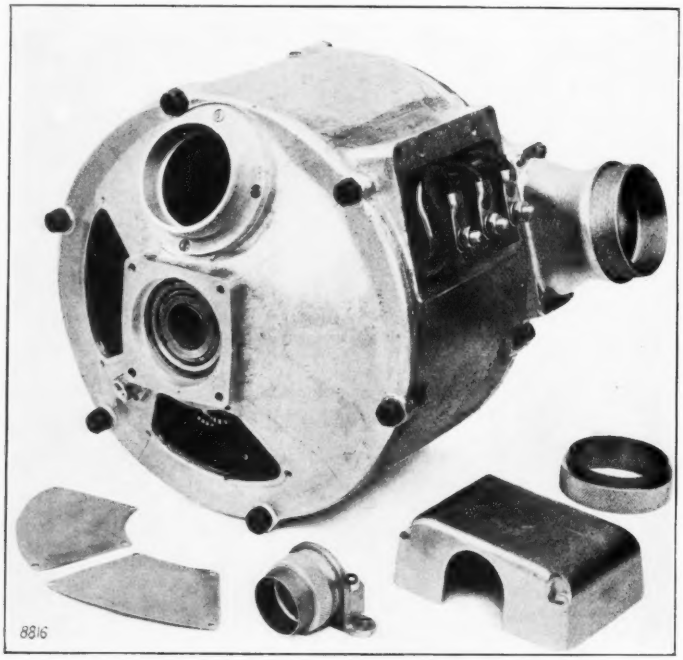


FIG. 14.

Rotax 10 kw. alternator.

the engine. This fan also serves to cool the alternator. The engine is built to run continuously at high speed, and economy of running even when throttled is given by the high compression ratio. A fuel consumption of 0.5lbs. per h.p. hour under full load conditions is estimated. A governor holds the speed constant to within ± 5 per cent.

The dry weight of the bare engine is about 80lbs., and the alternator weighs 91lbs., so that the weight per kilowatt compares favourably with that of other units.

DISCUSSION.

Mr. C. P. T. LIPSCOMB (*Associate Fellow*): The authors had put forward a very clear statement of the position as it was to-day.

Mr. Chaplin had pleaded for the retention of electricity and hydraulics only, and he was inclined to agree, especially if he would make the division 90 per cent.

electric and 10 per cent. hydraulic. He thought Mr. Chaplin was not quite fair when making comparisons between the weight of hydraulic and electric motors as sufficient consideration had not been given to the respective weights of pipe-lines and oil as against cable.

On a large aeroplane at present in service the length of pipe line to operate a particular component is approximately 170ft. (out and return), the weight of which with oil is considerable.

Another disadvantage which he rather glossed over in the case of hydraulics was the unpleasantness of a broken pipe line, and this was not going to be improved by the suggestions made of increasing the pressure in the lines to reduce weight.

He had heard of one pilot who forcibly complained of being soaked with oil the whole time on a long flight owing to a broken pipe.

The vulnerability of oil pipe lines in war was, also, a serious consideration and was a point in favour of the electric service as duplication, if desirable, was easier to arrange.

He, being in favour of an all-electric service, was interested in the development of a separate generating unit.

There were still many problems to be solved, but with increasing demands on ancillary services they would be forced to a consideration of the independent power unit as the weight of batteries would soon be prohibitive. He was in favour of the 110-volt unit in order to reduce the cable weight. On a large machine this, with the necessary protection, may be in the neighbourhood of 500lbs., so the saving might be considerable.

Mr. Chaplin was rather pessimistic concerning the dangers of the high voltage circuit, but with modern system of conduits and the stringent regulations regarding cables, etc., the position should be well safeguarded.

He agreed that the independent power unit could only justify itself on aircraft considerably larger than present types, and it might be necessary to reach 100,000lbs. in weight before the independent unit fully justified itself.

He would prefer the alternators driven from the main engines, but in view of the necessity for some of the services to be in operation when the main engines are not running it would appear necessary to concentrate on the independent type.

The remarks made regarding cartridge starting were interesting and the method sounded attractive, but he had been told that with some engines, on a cold day, five to nine cartridges may be required to start, making the cost of starting prohibitive to a civil operating company.

In his experience, he said, electric starting had always been satisfactory.

The paper would do a great deal to focus attention on certain problems, the solution of which was very desirable at the present moment.

Mr. G. H. Dowty (*Fellow*) said that there was one point which both authors had stressed in connection with high and low pressure hydraulic equipment on aircraft. They both seemed to be under the impression that it was necessary to have a separate hydraulic power unit for each of these services, whereas a high pressure pump can supply both the high and low pressure services without duplication. Strong criticism had been made by Mr. Chaplin on the score that one aircraft had five independent hydraulic services. That criticism should be more clearly defined. He thought Mr. Chaplin was referring to aircraft fitted with gun turrets where each turret operated on a separate system. While he realised that the gun turret manufacturers had their own difficulties, he did feel that they were the "bad boys" who had brought forth this criticism. Mr. Chaplin referred to the variable delivery pump, and here he thought he had made a very good point. This pump will simplify hydraulic circuits enormously. They were fortunate in shortly having available a pump of this type, one which would also raise the operating pressure to 3,000lbs./in.^{2}

The previous speaker was rather critical about hydraulics, and he concluded that he had no great experience in this field. Among thousands of installations he himself

had yet to hear of a pipe bursting. The authors had also made reference to the weight of hydraulic installations, and it was interesting to note that over a large number of aircraft the total installation weight, including engine pump, came out at 0.8 per cent. of the aeroplane gross weight for bombers, and 0.5 per cent. for fighters. With the introduction of the variable delivery pump it was expected to effect a saving of 35 per cent. on present equipment weights. If this was compared with electrical equipment available to-day, it would be found impossible to substitute electrical equipment under twice this weight.

Another point raised by Mr. Nixon was of very great importance, especially to civil operators, namely, that with hydraulic equipment only mechanical knowledge was required on the part of the maintenance staff.

Mr. PURKISS: Discussing the problem entirely from the installation point of view, he said that most decidedly they must get down to not more than two services. As the result of an earlier paper he was credited with favouring hydraulic supply; one aspect of hydraulic supply which might be investigated—and they were on the fringe of it—was the very high speed centrifugal hydraulic motor, and he pointed out that very large power could be obtained from a very small component rotating at probably 10,000 or 12,000 r.p.m. Working at the higher pressures the pipes were comparatively small, and they compared very favourably with the cable required for a high voltage electrical system. That was his thought for future development, and it was worthy of close attention.

Mr. R. H. WOODALL (*Associate Member*): As a designer of electrical equipment he visualised the all-electric aircraft of the future. On studying the situation closely there was no service on the aircraft which could not be operated electrically. It was possible to operate brakes electrically, and development was proceeding in that direction; the electrical operation of flaps, etc., was coming in rapidly, and its development would be still more rapid with the adoption of an alternating current power plant.

Nobody would dispute that electrical service was essential for wireless and lighting; those services could not be operated hydraulically. Inasmuch as an electrical system must always be installed on aircraft, therefore, why should not electricity be the primary source of power? The electrical supply must be of fairly high voltage. Although Mr. Chaplin had called attention to the dangers of high voltage, or the 110 volts which he had called high voltage, Mr. Woodall suggested that there was no danger at all. One could not even maintain an arc with a 110-volt supply; and the short-circuiting of a battery was far more liable to cause a fire than was the short-circuiting of a 10 kw. alternator, the short-circuit current of a battery being much higher than that of the alternator.

Expressing agreement with Mr. Lipscomb's remarks concerning cable weights, he said that on a "C" class flying boat the starter cable weight was approximately 104 lbs., using a 24-volt d.c. system; and if a 110-volt system were used, the cable weight could be reduced to about 36 lbs.

Although the authors of the paper appeared to favour the increase of hydraulic pressure, thus giving an opportunity for the reduction of the size of pipe lines, they were not in favour of reducing cable weights by the use of electricity at higher voltages.

In calculating the comparative weights of electrical and hydraulic equipment, the authors had omitted to add the weight of the hydraulic pump. But since it was already assumed that a generator and battery were used for wireless purposes, then in comparing the electrical and hydraulic operation of flaps one must naturally add the weight of the hydraulic pump and the pipe lines in the latter case. On a particular installation a four-engined boat, on which hydraulic and electrical operation of flaps had been applied, the actual weights were 100 lbs. for hydraulic operation and 99 lbs. for the electrical operation.

It seemed to have been suggested by Mr. Chaplin that the electrical problems were not tackled in the same spirit as were the hydraulic problems, but no grounds could be found for this assumption.

With regard to what was referred to as high frequency—although, of course, it was actually low frequency, for the proposal in this country was for 400 cycles—he said there would be no trouble due to the effect of that frequency on insulation; frequencies had to be much higher before any trouble of that nature occurred.

As to the statement that, although much commercial plant existed for normal frequency, none of those could be applied to aircraft use, he said he had never yet been able to consider a standard piece of commercial apparatus for use on an aeroplane; a specially designed piece of apparatus was necessary to meet aircraft conditions.

Commenting on the reference to the musical note which would arise from a frequency of 800 or 400 cycles, he said he was given to understand by the radio experts that it was not likely to be a source of trouble and had not proved a drawback in the United States. It had even been thought that it might be used for modulation purposes.

Finally, in view of the remarks of Mr. Purkiss concerning the high speeds of hydraulic pumps, he pointed out that the electrical designer was also able to provide for increased speeds of operation, particularly when an A.C. power plant was available; there had been difficulties with the commutator and brush gear, but those components would disappear when an A.C. power plant was available.

The authors' statement that little, if any, weight is saved by adopting 110 volts as against 24 volts, owing to increase in cable insulation necessary, is strongly disputed. The thickness of the insulation on 24-volt cables is necessary for mechanical rather than electrical reasons, and no increase in the dielectric thickness would be necessary for 110-volt circuits. The analogy between the electrical and hydraulic systems mentioned above applies equally well in this instance, and the authors would not admit that the pipe lines of high pressure hydraulic systems were not lighter than low pressure pipe lines.

The 110-volt 400- or 800-cycle alternating current system will, it is felt, find favour in the first instance on aircraft of 30 to 40 tons, but may ultimately be used on smaller craft of, say, 20 tons.

The reasons will be (a) the considerable reduction in the weight per kilowatt generated, (b) the absence of radio interference from the electric motors, etc., on the ship, due to the elimination of commutators and brush gear, (c) the advantages accruing from the removal of the power plant from the main motors of the aircraft to an accessible position in the fuselage.

The writer is inclined to agree with the authors that some form of electro-hydraulic system may be necessary for gun turret operation.

The authors are to be congratulated on presenting a paper which has proved so interesting and has provoked so controversial a discussion.

Mr. F. M. Thomas (*Associate Fellow*): Discussing problems relating to the airscrew, he said that the latter should properly be included among the list of services for which power was required, because the pitch could not be changed unless some source of power was available for the purpose. One could obtain that power from a source of stored power as is done with electrically-operated airscrews, or from the forward motion of the aeroplane as with some airscrews with little propellers in front, or one could obtain it from the engine by direct gear transmission or by indirect but more easily regulated hydraulic transmission. Many variable pitch airscrews existed using these various sources of power, and there is no fundamental reason why any of them could not be made satisfactory.

Hydraulic power had to date been used most successfully, but a matter which should be emphasised in respect of hydraulic power was that it must be transmitted to a rotating body; and if there is a leakage in the transfer system, as there was in most transfer systems to-day, engine oil must be used. But there was hope of designing oil transfer systems which did not leak and which would permit one to use, not engine oil, but an oil most suited for the purpose.

Commenting upon the four-airscrew requirements listed in the paper, he suggested in the first place that the pitch indicator was not necessary because in his opinion it did not serve a use which justified the weight and complication involved. He suggested that it called for as much ingenuity to make a pitch indicator work as to make an airscrew work.

If a feathered airscrew were used, a brake was not needed. If it were contended that a brake was needed on a feathered airscrew to stop it rotating, then that airscrew, together with its engine, was so mechanically efficient that the slightest aerodynamical unbalance started it rotating; and in most cases he did not think power plants were efficient enough to require a brake. If, however, a brake were needed, he felt that the hydraulic brake was certainly the best.

Any source of power for feathering hydraulic airscrews was quite all right; it did not matter where it came from, provided it was available when the engine was not rotating. It could come from electric motors or from a hydraulic accumulator or from an auxiliary power plant.

For a constant speed airscrew one must have a speed reference, but that speed reference need not be directly on the engine. At first sight one would say that it must be on the engine; but one could have another source of reference and relate the engine speed to it.

He did not feel competent to act as judge on the general problem of electrical versus hydraulic mechanisms, beyond pointing out a few basic considerations. One important such, he thought, was the necessity of making the systems work satisfactorily at very low temperatures, say, down to $-40°C$. This requirement offered difficult snags to electrical as well as to hydraulic systems, although its importance was most obvious in the latter case.

Another general consideration regarding the comparison between electrical and hydraulic systems for auxiliary power services concerned future development scope. He urged that in deciding a major problem such as the direction of the work for the next ten years, one should consider not only the advantages offered by existing methods and designs for the next six months, but should try to look ahead and decide which development had more in hand than another. His own belief was that hydraulic mechanisms were less near to ultimate design efficiency than electrical mechanisms, and therefore one could look forward to more improvement in general efficiency and reliability in hydraulic mechanisms than in electrical ones.

Mr. C. G. A. Woodford: The auhors' main contention that the present six different varieties of power service should be reduced to two cannot be gainsaid, and it is an undoubted fact that hydraulic characteristics are desirable for the various heavy duty operations. It is also clear that the history of hydraulics in aeroplanes has been haphazard, the present position is unsatisfactory and the future at least rather doubtful. At existing pressures leakage troubles, he believed, are not easy to avoid, and although this has been scantily treated in the paper, he had heard many opinions expressed as to the impossibility of preventing leaks, even in demonstration apparatus. Vulnerability of hydraulics has been admitted, but without, he felt, the necessary emphasis, presumably because of the belief that there is no possible alternative. The position under large scale war conditions may be imagined, and it is likely that with the high pressures contemplated even a cracked pipe might be fatal.

The introduction of electro-hydraulic turrets is therefore significant, but such systems cannot show the highest overall efficiency and lowest demand at the power source. Development of larger power demands are bound to raise problems in this respect. Moreover, an accumulator or overcharged main seems to be ruled out for such systems.

Is there another alternative? In this connection, attention is drawn to the constant current electrical system, which reproduces hydraulic characteristics in a series-connected circuit which has none of the usual fuses, cut-outs, and so on.

A constant current generator was introduced by Mr. Gilbert Austin, of Cathcart, and the system has been further developed by Laurence Scotts and the B.T.H. Co. and used for ships' auxiliaries, land capstans and heavy duty excavators, owing to its ability to stall with desired torque and regeneratively brake. Individual motors are short-circuited in switching off and the system lends itself to high diversity factor as met in aircraft services. Thus the generator need not be of greater capacity than the largest motor except for any additional constant load such as heating or cooking, which doubtless could be temporarily switched out if desired. Actually this could be taken care of by the switch for a particular motor.

The supply to the large power items would be very simple and robust comprising stout cable or, better still, solid aluminium conductors, in an endless circuit with the minimum of control apparatus and no insulation or leakage problems. Vulnerability would be very low. A constant current of, say, 100 amps. would need only 50 volts at the generator for 5 kw. suggested as being the largest single load likely to be required, and a heater of 500 watts would require a p.d. of only 5 volts with obvious advantage for safety, etc., the element being also simple and robust. The generator output would be available for heating during flight in the most simple and reliable manner.

It is thought that in most instances motors could be mounted in positions such as at wing roots or in fuselage and so facilitate a compact layout, a short flexible drive to worm and toggle gear for flaps, doors, etc., replacing jacks. U/C braking might be arranged by regenerative motors which also operate the legs and could be adapted to spin the wheels before landing.

Hence, there appear grounds for suggesting that the two essential services, viz., for light duties and heavy duties, should both be electrical. It is obvious that a constant pressure supply is still required for lighting, indicators, wireless, etc., and small gyro motors of which there would be an increased number, and generators larger than now available would be needed. A stand-by accumulator would be required as at present, which is sufficient justification for retaining 24 volts as standard. It has also been apparent for some time that much larger capacity accumulators are essential.

It is visualised that the constant pressure and constant current generators would be coupled together and driven in tandem preferably through an electric clutch. Emergency operation of the constant current flap and U/C motors could then be obtained by motoring the constant pressure generator from the accumulator to drive the C.C. generator. This possibility is in itself an argument for the dual electric system. In addition there is no difficulty in connecting duplicate direct current generators together as there is with other power sources. The tandem drives could be taken from either an auxiliary power unit or main engine and with multi-engines should be standard for all and fitted on both inboard units, the constant pressure generators being paralleled and the C.C. generators in series, and of 2 kw. and 5 kw. ratings, respectively. The directions of rotation should be standardised.

This is not the place to go into details as to the treatment of every requirement, but it may be mentioned as an example that he would expect to see engine starting carried out by using the associated C.C. generator as starting motor supplied from the other C.C. generator driven by its constant pressure companion from the aircraft or ground accumulator. With one engine running others could be started from the C.C. supply then available.

The weight of the C.C. generator for a maximum speed of 3,000 r.p.m. would certainly be greater than for a constant pressure machine of the same capacity, particularly if laminated throughout for rapid response, and might be so heavy as to rule it out for smaller aircraft, but this would have to be considered in relation to the great simplification brought about in displacing many lightly loaded services and the reduction of vulnerability. C.C. motors would be comparable

with standard types as special speed control governors usual with C.C. would probably only be needed in special cases such as turrets.

While the foregoing dual electric scheme is therefore put forward as a possible avenue of development, a few words about A.C. supply may be added.

The smoothing of H.T. supply for wireless, representing less than 100 watts, and reduction in size of iron cores do not appear to be sufficient justification for the new high frequency system proposed for relatively large units. It would seem that the high frequency is merely a fortuitous characteristic of a novel alternator. A number of possible objections have been cited, but he thought an important one is that it would not be practicable to have two such alternators working in parallel owing to synchronising difficulties; and in consequence any stand-by plant considered necessary would be additional dead weight.

Furthermore, a frequency of 100 to 200 C/S is sufficient to achieve the advantages of reduced iron cores and improved W/T smoothing and if an A.C. supply is desirable such frequency could be obtained with a four-pole alternator at 3,000 to 6,000 r.p.m. If this machine supplied 50 volts 3-phase all existing heating and lighting equipment, etc., for 24 volts could be retained side by side with the use of light 3-phase motors by connecting the lighting, etc., between phase and neutral lines, since the p.d. here would be nearly 29 volts or equal to that of the D.C. generator on 24-volt system. A reasonable power-weight ratio of generator would be obtained and greatly increased power transmission capacity of existing " quadragen " cables.

It should also be possible to design static voltage regulators for the generator, and a stand-by accumulator for emergency lighting, wireless, indicators and cartridge or other form of engine starting, could be kept charged through a metal rectifier.

The introduction of such a system might logically form a step forward from the present super motor car technique with the provision of engine-driven alternator of, say, 3 to 4 kw. for small and medium sizes of aircraft where heavier constant current plant might not be admissible or in combination with a limited hydraulic system if this were considered essential for any particular service.

In general it is felt that all-electric operation should be seriously developed in the conviction that the electrical industry can supply all the necessary apparatus as well as the maintenance personnel, thereby relieving more than one of the present-day aircraft problems.

Captain A. FRAZER-NASH: His experience had been confined almost entirely to military machines. The present hydraulic pressures had been forced upon them by the limitations of various flexible pipes which they had had to use when the systems were installed. They had had no knowledge of what would be required, but had had to start from scratch, and everything had followed up so quickly after that, that they had had to go straight ahead with it. But he referred to a high-pressure unit that was being developed within one of the Air Ministry ranges, *i.e.*, between 1,000 and 1,200 lbs. Incidentally, he did not understand the reference by the authors to a range of from 1,200 to 1,400 lbs., because the Air Ministry had laid down three ranges—1,000 to 1,200 lbs., 2,000 to 2,400 lbs., and 4,000 to 5,000 lbs., and he asked that future designs should be somewhere within those ranges, and not between them. However, the future arrangement he had mentioned was to make use of an automatic variable delivery pump at constant pressure, the idea being to use a change-over valve, operated by the pilot, to work his flaps, undercarriage, and so on; and the bomb doors and turrets could all work from the one unit. The proposal for twin-engined machines would be to have two pumps, either or both of which would be available to supply the common system.

He was afraid that the developments likely to arise would call for rather a lot of power for the turrets. A difficulty in connection with turrets was, when using the cine-gun, that the target must be almost plumb in the middle of the sight;

when one saw the cine-gun results one realised the difficulty as compared with other services of the machine.

Unless electricity was used in conjunction with a hydraulic system it was not suitable for turrets. Its use alone had been tried by a number of people, but had been discontinued. There might be some development about which they did not know at present, but with their present knowledge he could not visualise its use except in conjunction with a hydraulic system for turrets.

With regard to the independent unit, he did not think it had been sufficiently emphasised that not only was it useful for starting up engines when on the ground or in the water, and also for wireless purposes in those circumstances, but it was also very useful for servicing and manœuvring turrets without having to run up the main engines. In this country they might have portable engines and plug the pipes in, but abroad it might not be so convenient to do that, and an independent unit certainly would score in that respect.

Mr. P. G. Lucas: Speaking from the point of view of the pilot, he urged that it was absolutely essential to limit the services to the very minimum in order to simplify maintenance. In his own experience, hydraulics were certainly very much easier than other systems to look after. Leaks in hydraulic systems were very easily traced because leaking oil could be seen, whereas in the case of high-pressure air systems, particularly on big aircraft, where there were many long pipes and joints, leaks were difficult to trace. Again, one did not require the services of a highly skilled person to look after hydraulic systems, for as a rule they were very foolproof and fairly accessible and the parts could easily be changed. He urged that ease of maintenance must be considered before anything else.

Mr. Harding (who was invited by the President to speak because of the great attention which had been given in America to accessory equipment): Reference had been made to hydraulic pressures from 200 up to 3,000, 4,000 and 5,000 lbs. He was wondering what would be done with a pressure such as 3,000 lbs., because the minute one applied a pressure of 2,000 lbs. or even 1,000 lbs. in a pipe, the latter became almost like a steel rod, being subject to vibrations of all kinds, so that the smallest leak would be dangerous and all the fluid would be gone immediately. From his little experience of hydraulic equipment in the United States it seemed that they had standardised very well with pressures of 1,000 lbs.

Having seen a number of installations, he suggested that in some of them the storage reservoirs could well be placed nearer the pumps; and he did not think it was necessary to put the pumps on the engines, for they could easily be driven by small electric D.C. or A.C. motors and located close to or adjacent to units they were supposed to operate. By that means much weight was saved in installations.

Mr. I. O. Hockmeyer: He considered that the paper was a very rational approach to the subject, and that the authors had made out a very good case for reducing the number of services. His approach to the subject had always been to justify, or investigate, the A.C. auxiliary power unit as such; the conclusion is, as stated by the authors, that as the electrical load increases, the weight per kw. to generate will decrease. That was really the axiom given in the second part of the paper. He had no opposition to the retention of hydraulics, for he did not know sufficient about that aspect of the subject, but he agreed that three-phase squirrel cage A.C. motors should be quite suitable for replacing air-driven gyros.

It was necessary to decide the issue between the main drive and the auxiliary power unit drive before commencing to discuss the type of electrical supply to adopt. The authors had set out the comparison between the main drive and the auxiliary power unit drive fairly well. The list of requirements for power service, as given in the paper, included "No. 7.—Capable of storing energy (to meet the exigencies of failure)." Stored energy is, however, also essential on the ground for operational requirements, including starting, and for testing. It was stated in the paper that electricity was the only means of giving an unlimited number of starts; but that was certainly not true with accumulators. He had

complete faith in electrical generators and he was fully convinced that they could be designed to be thoroughly reliable. He did not say that that had been the experience in the aircraft industry,. but there was no reason why it should not be achieved.

An installation should be able to run from one normal overhaul to the next quite happily. In that connection he mentioned that the Holyhead Power Station had, some years ago, been dependent on one balancer which ran for periods of twelve months continuously; it had been the practice to shut down the station on one Sunday afternoon in the summer in order to look at it, after which it would go on for another year.

Advocating duplicate engines, he said that one alternator should have two auxiliary power units, because the auxiliary power unit engines could not be so reliable as the alternator, which was merely a rotating mass subjected to medium temperatures, whereas the engines had reciprocating parts and were subjected to combustion temperatures. The two engines need not each be capable of dealing with the whole load. They could be of equal size, or one could be big enough to deal with essential loads, whilst tne other could deal with the balance. He was in favour of the former alternative.

With regard to the authors' suggestion to use a main alternator and a small auxiliary power unit, and to Mr. Woodford's advocacy of the constant pressure generator plus constant current generator, he suggested that both these proposals meant multiplicity of services, which was the very thing they were trying to avoid. On the one hand they were trying to reduce the number of services, and on the other hand they were putting in two electrical services where at present there was only one. It might be said that he was contradicting his own argument, where he had suggested two engines to drive one alternator, but this was necessary for reliability. The authors objected to the auxiliary power unit because of the sound- and fire-proofing entailed, and yet two paragraphs later they advocate a small auxiliary power unit for ground use, which would also need sound- and fire-proofing. They might just as well proof the big one as the little one.

Discussing weights, he said that a 1,000-watt main engine-driven generator weighed about 35 lbs., and a gearbox weighed about 1 lb. per h.p., making 2 lbs. for a 1,000-watt generator. Two 25 ampere-hour 12-volt accumulators weighed 64 lbs. Thus the total weight per kw. on a 24-volt system was 101 lbs. They were told that a system comprising an alternator driven hydraulically from the main engine would weigh 26.6 lbs. per kw. But rectifiers and accumulators, for ground services, must be added to this weight; so that the 101 lbs. per kw. could not be compared with the 26.6 lbs. per kw.

Coming to the auxiliary power units, he quoted the authors' figures for the Douglas system of 50 lbs. per kw.; this was half the weight of the main generator system of 1,000 watts. The Rotax system is claimed to weigh 17 lbs. per kw. (Appendix V). That sounded almost too good to be true; it was not completed or working yet, and he presumed that when all the weights were added up, the total would be greater. The figures given were presumably design figures.

There was danger in making weight comparisons between auxiliaries driven from the main engine and those driven by separate power units. In the former case the power available from the main engine is robbed by the auxiliaries at the expense of aircraft performance. Thus the auxiliary power unit system can, economically, be a little heavier than the direct drive. It is also important to include in the balance sheet such items as accumulators, gearbox, and for the auxiliary power unit system, fuel and lubricant.

Referring again to the Rotax system, he said the fuel figure was $\frac{1}{2}$ lb. per b.h.p. hour (Appendix V). The weight of fuel for ten hours' duration at a 5 kw. load would be about 40 lbs.; adding that to the Rotax figure for the weight of the set, pushed up the weight/power ratio to 21 lbs. per kw. If those figures were

true, he could not see why everybody should not jump for that auxiliary power unit, for it seemed streets ahead of anything else.

Finally, he said that in considering the pros and cons of weights, one had to take into account the consequential effect on the auxiliaries themselves, and that seemed a very indeterminable thing at the moment.

(*Communicated.*) He had already discussed various points regarding the relative merits of the main engine drive and of the auxiliary power unit, and he now dealt with the choice of electric supply. He considered that, for large aircraft, A.C. has definite advantages over D.C. The main reasons are the absence of commutators, which are the principal source of radio interference, the ease of voltage transformation, and the fact that squirrel cage motors can be used.

The authors favour L.T. as opposed to H.T. They have overlooked the fact that the multiplication of plug and socket connections, inevitable in large modern aircraft, causes serious difficulties on L.T. systems due to voltage drop. As stated by other speakers, cable weight will be reduced considerably by the use of H.T.; this will be offset, to some extent, by transformers. Transformers will be required to reduce the voltage to low wattage lamps; the danger, visualised by the authors, of lamp failures due to the use of thin filaments need not, therefore, arise. The authors expect H.T. to be more dangerous than a L.T. system; one speaker in the discussion disagreed with this view. The writer, too, felt that the danger should not be greater. The absence of accumulators, the source of big short-circuit currents, and the inductive effects present in A.C. circuits, will tend to reduce this possibility. Fuses would provide ample protection.

The use of fuses with electrics is a definite point in the vulnerability argument, discussed in the paper. Each electric circuit can be separately fused, whereas one puncture may put the whole hydraulic system out of action. The big asset claimed for hydraulics, namely, the simple blow-off valve, has equivalents in the electrical field. The fuse is the simplest, but it requires replacement; the alternatives are circuit-breakers (overload trips), which can be reset by hand or automatically, current limiting chokes (for A.C.), and, for motors, slipping clutches.

In conclusion, he submits that to discover which of the alternatives given in the paper is the panacea, something more than paper design and discussion will be necessary.

Mr. D. L. Ellis (*Associate Fellow*): Discussing the cooling of the auxiliary systems, he said that it was usually the responsibility of the aeroplane manufacturer; and including such things as the oil cooler, he might be faced with the problem of supplying anything up to five auxiliary cooling circuits in addition to the main one. A difficulty was that by the time he attacked the problem the design was usually so far advanced that there was very little latitude. The auxiliaries were carefully tucked in behind a large and hot engine, and the manufacturer was told at the last moment that he had to cool them. All that he could do was to provide a scoop sticking out into the air stream and conduct the air as best he could to the items requiring cooling. Their main cooling systems scooped up the air reasonably efficiently, cooled the engine and put the air back into the air stream with perhaps anything up to 80 or 90 per cent. of the energy still there; but the miserable little auxiliary systems were doing well if they left 10 per cent. of the energy in the air, and the gross result was that a complete set, with its attendant leaks, might absorb anything up to 5 per cent. of the b.h.p. There might be five or six separate circuits, all very inefficient; that meant perhaps 50 h.p. on a 1,000 h.p. engine, which was rather ridiculous.

Whilst he was bound to confess that at least three-quarters of the responsibility lay with the aeroplane manufacturer, he urged that the auxiliary unit suppliers would help in the attack on the problem. The obvious solution at first sight was to use one efficient ducting system and to place all the auxiliaries in it; but the mountain would not go to Mahomet, so that they still had to take the air to the auxiliaries. They might compromise by using one entrance system, expanding

the air efficiently, and then ducting it at a low velocity to the individual units. The problem was becoming very serious and any assistance which could be given in the way of altering the position of the units would render its solution very much easier.

Mr. F. MAYER: He was glad that the respective authors had referred to voltages of 110 and 120, for one looked to them to talk in terms of one standard. One of the early troubles in regard to hydraulic systems, however, was due to the varying pressures that were put forward, some manufacturers speaking of 300 lbs., others speaking of 400 lbs., and so on; and he urged that they should try to consider the problems of the application of hydraulics in aircraft in terms of one standard pressure.

With regard to Mr. Lipscomb's point that 100,000 lbs. was the lower limit of weight of aircraft in which it would be economical to use a large all-electric auxiliary power unit, he said there must be some weight above that at which duplication of that unit would be necessary.

Mr. LIPSCOMB: He presumed that it would be necessary.

Mr. MAYER: Discussing fire risk, he said there was a rather general idea that the breaking of a high-voltage circuit was more dangerous than the breaking of a low-voltage circuit. But he did not think that was necessarily the case. Even with a low voltage, if there were a low resistance and plenty of battery power, there was a fire risk.

In a case where the engine drove the accessories through an auxiliary gearbox and the accessories had to be ground-tested in the course of the maintenance of the machine, it was a good thing to provide an attachment to the auxiliary gearbox so that a hand electric control could be coupled to it, so enabling the accessories to be tested without running the engine.

Emphasising the importance of limiting the number of types of service in order to limit the number of specialists required for their maintenance, he said that well-educated and well-trained men would be required for the maintenance of the modern electrical and hydraulic equipments.

He believed the hydraulic power system could claim some small advantage in that it tended to overcome peak loads rather better than did an electric motor system; the latter tended to stall and to stop more readily under maximum load conditions.

Mr. W. BAMFORD (*communicated*): It is quite evident that electrical power is a necessity on aircraft and in order to cut down the number of services, its use should be carefully considered for all possible duties. The first part of the paper does less than justice to electrical methods and equipment and one or two popular misconceptions should be removed.

The voltage at present widely used, namely, 24 volts D.C., was selected because the weight efficiency of a lead acid battery is probably at its best at this voltage. Mention is made in the paper of 110 volts A.C. as " high " voltage, but to the electrical engineer such a voltage is really quite low and modern systems can be run at much higher voltages than this with perfect safety and reliability.

When it is realised that the cross section of an electrical conductor varies with the square of the current, the saving in conductor weight by increasing the voltage by, say, four or five times, can be appreciated. The disadvantages detailed in the first part of the paper in connection with electrical insulation must be modified, as insulating materials are now available which are non-hygroscopic and non-inflammable, and also mechanically strong and resilient.

No doubt in America 110 volts A.C. would be attractive as it is a common standard in use there, but in this country a 230/400-volt 3-phase 4-wire A.C. supply is most universally used at a frequency of 50 cycles. The question of voltage and frequency of an A.C. supply on aircraft should, therefore, be con-

sidered very carefully, particularly as the saving on transformer cores is quite small for frequencies in excess of 100 cycles.

In the event of breakage of electrical conductors, the amount of arcing is not altogether dependent upon the system voltage. Indeed, on 230 volts A.C. the arcing is, in general, less than on a 24-volt D.C. supply, and danger from this source need not be expected.

The adoption of alternating current as a power supply offers considerable advantages in the way of maintenance, for the 3-phase A.C. motor of the squirrel cage type is most reliable and the only maintenance required would be mechanical (bearings). As the electrical circuits on the machine can be adequately split up and protected, faults may be very quickly isolated and here an advantage may be claimed over the hydraulic system where mechanical damage would be very difficult to deal with in flight. The increase in pressure of an electrical system does not involve very great problems, whereas the corresponding increase in the pressure of the hydraulic system does. The radio engineer will look upon 8,000 volts in his equipment with equanimity. The constant current system mentioned during the discussion has many attractive features, but as it still retains the D.C. motor with its commutator, brush gear, etc., it must be considered with caution.

Having decided that electrical power must be available the problem devolves into the conversion of some of the mechanical energy from the main engine into electrical energy and the suggestion put forward in the second part of the paper that this should be carried out by means of a hydraulic pump and a hydraulic motor driving an alternator cannot be too strongly emphasised. The hydraulic mains under such a system need only be short and easily accessible and at the same time, hydraulic power is available for duties which may be better performed by that means. This conversion of energy might also be carried out by means of a compressor on the main engine and an air motor driving the alternator, the advantage being that reserve power could be available in bottles, both in the aircraft and when the machine is on the ground. Such a source of reserve power could very easily be provided at all aerodromes.

Mr. S. M. PARKER (*contributed*): In paragraph 6.1 Mr. Chaplin has pointed out the weight of the electrical motor in comparison with the equivalent hydraulic jack. What is of much more importance than this, however, is that the motion from the electric motor is fast rotary which is unusable in that form and is usually converted to slow rotary and then to linear motion whilst the motion from the hydraulic jack is itself linear.

The loss of efficiency and greater weight implied by this arrangement, in addition to its maintenance, seem to point to an almost overwhelming fundamental superiority of the hydraulic jack for all operations requiring linear movement.

In paragraph 10 Mr. Chaplin mentions the term " hydraulic main "; this term in its usual application implies a form of potential energy. In this respect it cannot be applied to hydraulic systems which are designed on a displacement basis, unless there is interposed in the system some form of hydraulic accumulator. This arrangement plus an automatic cut out valve can in a twin-engined installation reduce the size of the pumps and the delivery pipes from them, since the pumps are not called upon to deliver at the maximum rate of consumption at any time.

At the beginning of his paper Mr. Nixon has suggested that opportunities have been lost by firms specialising in hydraulics to rationalise the whole of the hydraulic system. It should be pointed out that in some cases a considerable amount of success has been achieved in this direction despite the difficulty that many contractors were unwilling to put " all their eggs in one basket." It should also be realised that in a hydraulic system it is not normally easy to make last minute additions, and that rationalisation is a much more practical proposition now that contractors can agree at an early stage what services are to be operated hydraulically.

In paragraph 2, Mr. Nixon states that the pipe line is vulnerable and cannot be duplicated easily. This is not at all the case, and duplex systems with the simplest form of valving are in use on a number of aircraft to-day. It must be clearly understood that suitable provision must be made for loss of fluid if the normal line is cut.

During the discussion which followed the lecture, certain figures were stated regarding the comparative weights of hydraulic and electrical installations. It can be shown that the transmission lines on a basis of 24 volts against 1,000 lbs./sq. in. pressure are much the same weight per foot run; that the hydraulic jack is normally very much lighter than electric motor plus reduction gearing, plus worm gearing; that the hydraulic engine pump is very much lighter than equivalent generator, and that in the matter of controls only, which are a small proportion of the total weight, does electricity show a saving in weight of the hydraulics.

It seems reasonable to assume, therefore, that as a whole the hydraulic system should definitely be lighter than the electrical system, and there seems little reason to suggest that these premises should not hold good as voltages and pressures increase in approximately the same degree.

Reply to Discussion.

Mr. Chaplin: Replying to Mr. Lipscomb's advocacy of electricity and his reference to the unpleasantness of broken oil pipes, he suggested that broken oil pipes were no more unpleasant than broken electrical connections. Indeed, from the point of view of vulnerability in warfare, he suggested that broken electrical connections were considerably more serious than broken pipes.

With regard to the prospective weights of pipes and cables, Mr. Lipscomb had admitted that on certain aircraft the weight of cables was 500 lbs. This was indeed such a prodigious figure that it was difficult to believe that pipe lines with their oil could weigh even a fraction of this amount, thus appearing to disprove Mr. Lipscomb's implication that cables were lighter than pipe lines.

He agreed with Mr. Dowty that a high pressure pump could be used for supplying both high and low pressure services. But he pointed out that usually, where low pressures were used, one could not afford to reduce the power generated by the high pressure pump in order to use it at the lower pressure.

Dealing with reference to the safety of electricity, which was said to be demonstrated by the fact that the housewife was able to use it in the home, he said there had been electrical fires in houses and there had been cases in which housewives had been electrocuted, and he did not think we could afford to run such risks on aircraft.

Whilst he agreed with Mr. Woodall that brakes could be operated electrically, he said he still maintained that probably they could not be operated so simply and efficiently by electricity as they could be hydraulically.

It was true that a short circuit on a battery system could be very dangerous, provided the battery had sufficient capacity behind it to do real damage. But he pointed out that circuits were protected by fuses, and that when the current was above the normal value, the fuses would blow. If a short circuit occurred on a high voltage circuit—and a 100-volt circuit was relatively high for aircraft—an arc could be set up; the amperage of an arc was not very high, and the fuse would not necessarily blow, so that surely that arc could cause damage on an aircraft.

He could not agree with Mr. Woodall that the disadvantages and dangers arising from an increase of pressure in hydraulic circuits were comparable with those arising from the increase of pressure in an electrical circuit. There was not time to go into detail, but the danger was much greater in the case of the electrical circuit than in the case of the hydraulic circuit.

It was of interest to note that Mr. Woodall had been able to quote an example in which electrical equipment had an advantage over the hydraulic in respect of weight, the weight of the electrically operated mechanism being 99 lbs., as compared with 100 lbs. for the hydraulic. Probably he had had to go a long way to find even that example!

Mr. WOODALL: He commented that one had worked and the other had not.

Mr. CHAPLIN: Recalling Mr. Woodford's reference to new developments in connection with the constant current type of generated electrical power, he said he hoped to communicate further with Mr. Woodford in regard to it.

It was interesting to note that even the electrical people seemed to be at variance as to the best electrical system to use; he did not know whether that was a good thing or a bad thing!

He was unable to understand Mr. Harding's contention that a pressure of even 1,000 lbs. per sq. inch was high, as not only was this a pressure that had been in general use for some time now, but also Mr. Harding himself stated that in his experience this pressure had been standardised with success in the United States. Of course, the use of higher pressures would have to follow progressive experiments; nobody would try to jump straight from a pressure of 1,000 lbs. to 3,000 lbs. per sq. inch.

Finally, he said it would seem that the use of an electric motor driving a separate unit could be justified only on very large aircraft, where the saving in pipe length would be considerable.

(*Communicated.*) Although he felt that his spoken reply dealt reasonably well with the outstanding points raised in the discussion, he would have liked to have gone very much more fully into some of the more technical aspects, particularly those concerning the considerations connected with electrical systems. Owing to unforeseen circumstances, connected chiefly with conditions arising from the advent of the present war, he regretted his inability to devote the time which the discussion undoubtedly deserved. However, he thought it worth while recording the following rather hastily conceived comments upon the observations made by various speakers.

He felt that it was hardly fair for *Mr. R. H. Woodall* to add in the weight of the hydraulic pump when considering the operation of any one component, since this same pump would be the source of energy for all the hydraulically operated mechanisms on the aircraft. Moreover, as Mr. Woodall is an advocate of the relatively high voltage alternator he must add in the weight of a transformer and rectifier for any batteries carried. This speaker, as well as several others, had objected to the authors' reference to high voltage and high frequency. These terms are, of course, relative and are surely correct when a comparison is being made with a normal voltage of 24 and a standard frequency of 50 cycles.

It was encouraging to hear *Mr. F. M. Thomas* state that he believed there was still room for improvement in hydraulic mechanisms, but that he felt electrical ones had almost reached their limit of improvement. Considering the popularity and success of hydraulic methods of operation in their present undeveloped condition, there appeared to the author little hope for the future of electrics.

Whilst appreciating the fact that *Mr. C. G. A. Woodford's* suggestion for the adoption of the constant current electrical system offered a new aspect from which to examine the question of the retention of electrics as the only system, the author felt that it still left unchallenged certain important hydraulic advantages referred to in para. (6.1) of the paper. He regretted that there was not the opportunity to examine, in the detail it deserves, the proposition contained in Mr. Woodford's contribution, but it appeared that the nature of the suggestion is such that it should be discussed and settled between electrical engineers who would appreciate the finer points of the constant current system.

Appreciating the reasons given by *Captain A. Frazer-Nash* for the present use of low pressures in turret work, he pointed out that comments to this effect were

contained in the paper. He was encouraged to learn from such an authority as Capt. Nash that work was already in hand on a unit using the higher pressures (for which a pious hope had been expressed in the paper). The same speaker had commented upon the author's reference to a 1,200-1,400 lbs. per sq. in. range when the Air Ministry were attempting to standardise among other ranges one of 1,000-1,200 lbs. per sq. in. The mention of 1,200-1,400 lbs. per sq. in. was made without any reference to the proposed Air Ministry standard and was based largely upon the extensive use which was then being made of the Lockheed Mk. IV pump which operated systems successfully at those pressures. It was pleasing to note Capt. Nash's assertion that hydraulics were essential for turret work, whether electrics were used or not. It is obvious, moreover, from the results obtained by the turrets of Capt. Nash's design that electrics are by no means essential. Whilst cordially appreciating the points mentioned in favour of the separate power unit, the author could not feel that they were by any means sufficient to outweigh the objections stated in the paper.

He was interested to note that *Mr. I. O. Hockmeyer* had pointed out that one of his electrical associates, Mr. Woodford, in suggesting constant current generation, was putting in two electrical services where there was previously only one. This surely goes a long way to invalidating the proposal. The author would remind Mr. Hockmeyer that in the paper it was not suggested that there was not the equivalent of the " blow-off valve " in the electrical field, but had stated that this effect was not so simply achieved electrically. He still submitted that the circuit-breakers, slipping clutches, etc., mentioned by Mr. Hockmeyer, are not so simple as the hydraulic blow-off valve.

Upon one point of general electrical interest already referred to in his spoken reply, the author would like further information. One or two of the protagonists of the relatively high voltage electrical system had stated that the risks from arcing were no greater than with the low voltage system. With a certain amount of temerity—professing only a limited electrical knowledge—the author would like to reaffirm his inability to find evidence to contradict the assertions made in his spoken reply. As far as he could determine, a minimum of 39 volts were necessary for sustaining an arc. Thus an arc could not be maintained on a 24-volt circuit. On a circuit of more than 39 volts an arc could be maintained, and provided its amperage were not too high, the relevant fuse would not blow.

In conclusion, the author would like to thank speakers and contributors for their lively interest and appreciation. In reviewing the discussion generally, he would like to point out :—

(1) None of the supporters of the independent power unit had suggested how the smaller aircraft were to be satisfied, nor, alternatively, had they the courage to admit that entirely different systems must be adopted for large and smaller aircraft respectively, as mentioned in para. (7) of the paper.

(2) The all-electrical enthusiasts had not been able to dispose satisfactorily of the hydraulic advantages mentioned in para. (6.1). Particularly the fact remained unchallenged that hydraulic jacks had the big advantage over electric motors in that their weight was usually small since it depended on the energy handled and not on the speed of handling it, *i.e.*, not upon the horse-power.

(3) Several staunch supporters of electrics had come forward, but there appeared between them such a diversity of ideas as to the best electrical system that one began to wonder if any of the systems were really sound. Apart from that, it was evident that the electrical people could perform a very useful service by discussing this problem under the auspices of one of their institutions and presenting their conclusions to the aircraft industry.

(4) In general, no conclusive reasons were put forward to condemn the sum total of the recommendations contained in para. 12. Further, those suggestions which had been made during the discussion had, in settling one part of the question, left unanswered another part of it, and in many cases had themselves introduced new problems to which, at the present time, there appeared no satisfactory answer.

Reply to Discussion by Mr. Nixon.

Mr. Nixon: Mr. Chaplin would agree that the effort put into the preparation of the paper had been fully repaid by the excellence of the discussion. He had tried to maintain a neutral position in respect of hydraulics and electricity, for his function was to provide the power required, and not to decide whether it was to be provided hydraulically or electrically. It had been most interesting to hear the advocates of the different systems, and he would like to thank everyone who had taken part in the discussion.

He had been a little disappointed that Mr. Lipscomb had not dwelt at greater length on auxiliary power units, and particularly on the objection of having to supercharge them for altitude operation.

His own view with regard to permissible pressures in hydraulic systems was that it ought to be possible to use pressures in excess of 1,000 lbs./sq. in., but he did not think that a pressure of 5,000 lbs./sq. in. would be justified, as such a pressure would necessitate considerable stiffening up of pipes and component parts. He felt that a pressure somewhere between 2,000 and 3,000 lbs./sq. in. would be the optimum.

A point which he had tried to bring out in his conclusions appeared to have been overlooked by several speakers, while others had confirmed it. Viewing the contributions to the discussion impartially, he was more than ever sure that the system to be adopted for any particular aircraft would depend very largely on the services required on that aircraft, which meant that it would depend on the purpose for which the aircraft was intended. From the remarks of Captain Frazer-Nash it would appear that on military machines we should still need hydraulic power for the operation of gun turrets, and that electric motors would be unduly heavy. On military machines fitted with turrets the use of hydraulics should be extended to the operation of flaps, undercarriage and brakes therefore, in order to bring up the load factor on the hydraulic system. On civil machines, however, there was no essential hydraulic service, while the use of electricity was increased by the need for lighting, cooking, etc., so that in this field one would expect to find electricity applied more widely, to make the load factor as big as possible. It seemed probable that differences between types of services used in military and civil machines would persist.

Type of maintenance personnel had been touched on by Mr. Dowty, Mr. Lucas and Mr. Mayer. This point again was governed by the type and purpose of the aircraft. In the case of military machines, particularly the smaller ones, it was most important that maintenance should be simple and that relatively unskilled personnel only should be required. As machines became bigger, however, there would be need of a new conception. In the paper he had had in mind a maximum all-up weight of 60,000 to 70,000 lbs., but when the all-up weight approached 100,000 lbs., really skilled maintenance staff would be required, and special airports would become necessary. Very big machines would require a great deal of power when on the ground; passengers would demand comfort, and the machines would probably remain longer at the airports. Because the machines would have to go to their special airports, non-standard electrical systems could quite well be adopted, as provision could be made for them at these termini.

In considering auxiliary power units, it must be appreciated that they would have to be of sufficient capacity to ensure that full power would be available at altitudes of 20,000 to 30,000 ft., so that the auxiliary engines would have to be either supercharged or made over-size. On the whole, the total weight per horse-power would be lower when using the main engines.

(*Communicated.*) Rather unavoidably more time than usual had elapsed between the presentation of the paper and its publication. In the present instance this was an advantage, as it permitted of a reply to the discussion based on a more up-to-date knowledge of developments which were only forecasts when the

paper was presented. Of particular value has been the opportunity of discussing various aspects of the problem during a visit to the United States.

The author's primary concern is with the provision of power, and hence with the question of whether the main engines or auxiliary power units shall be used. It is interesting to note that there have been no outstanding developments in auxiliary power units, and that in the United States there is a tendency to decry auxiliary engines and to concentrate on the development of larger main engine driven accessories, although it must be emphasised that there is still a desire for service experience to establish definitely whether auxiliary power units can be justified. Further experience with accessory gearboxes has confirmed their value. In the electrical field they may shortly hear of constant speed engine-driven 110-volt generators of the size recommended by the author. In hydraulics they had seen the introduction of the " live-line " system foreshadowed by Mr. Dowty, at the pressure advocated by the author. In fact it has been pleasing to note that the general trend has been along the lines suggested.

Dealing now more specifically with the points raised, it is interesting to note that Mr. Lipscomb would prefer a main engine drive, but feels that the need for power on the ground precludes this. In the paper, however, the author has tried to make a case for main engine drive plus a small unit for use on the ground only, and he thinks that with this scheme Mr. Lipscomb's requirements can be met. Mr. Hockmeyer raises a pertinent point regarding fire- and sound-proofing, but it should be realised that the ground unit would be small compared with the duplicate units which would be required to motivate all the services, while because of its short time of operation the degree of sound-proofing would not need to be so high. On the question of duplication Mr. Hockmeyer is very interesting, although his remarks on reliability are calculated to raise the combustion temperature of anyone concerned with aero engines!

On the general question of electricity versus hydraulics, it is felt that too many people have disregarded the authors' claim that there is scope for both systems, and have instead tried to make a case for their own particular system. It has been interesting to compare Mr. Lipscomb's criticism of pipe lines with Mr. Lucas's statement. The proponents of electricity have been inclined to overlook the fact, mentioned by Mr. Parker, that it is possible and perfectly feasible to provide duplicate pipe lines (at the expense, of course, of weight), and thus to dispose of one of the chief objections.

One must admire the stand made by Mr. Woodall on behalf of electricity, but Mr. Thomas has put forward a very strong point, emphasised also by Captain Frazer-Nash, to the effect that the development of hydraulic systems has been haphazard up to the present time, and that in consequence there is much more scope for improvement than in the case of electricity. In this connection, too, Mr. Parker's remarks are interesting.

The author has been unjustly accused by Mr. Woodall and others, of opposing the adoption of higher voltages. Actually he has been careful not to express a definite opinion, not feeling qualified to enter into a detailed discussion on electrical questions. He has been very interested to read an article " A.C. for Aircraft?" by Mr. P. C. Sandretto, Communications Superintendent of United Air Lines, which appeared in the June issue of " Aviation," and to have received a most interesting letter from Mr. Sandretto, which unfortunately is too long to reproduce. The article and the letter set forth very clearly the pros and cons of electrical systems, and finally conclude in favour of the 110-volt A.C. system.

Touching on the electrical question generally, the author feels that the way in which the experts have quarrelled amongst themselves is both an augury of better things to come and at the same time proof that each system has its merits. Mr. Bamford's contribution is interesting as being that of one interested primarily in the electrical aspects without particular reference to aircraft. The proposal to use a compressed air drive, however, is opposed, both on the score of its

inefficiency and because compressed air is going out of use for other services and to employ it here would be to introduce yet another system.

Mr. Harding's advocacy of electro-hydraulic systems combines the drawbacks of both, and can only be justified in cases where additional services are called for on existing machines, and it becomes a matter of expediency.

Mr. Purkiss has put in a plea for a high speed centrifugal hydraulic pump. This suggestion is very interesting and in point of fact Rateau produced a centrifugal pump nearly 40 years ago which ran at 18,000 r.p.m. and gave 375 lbs./sq. in. with a single impeller 3.15 inches diameter. To give the pressures now required, however, the pump would probably have to have five or six stages, and such a design would not only be complicated and expensive, but it would not lend itself to variable delivery, which is well on the way to becoming adopted as standard on modern installations. Another objection lies in the fact that relatively small quantities have to be dealt with, especially as pressures increase, and this is always a difficulty with centrifugal pumps.

The PRESIDENT: Proposing a vote of thanks to the authors for their paper, he said that the paper and the discussion had brought home the importance of the classic remark of an American engineer, who was famous for his *bon mot*—simplicate and add lightness. These qualities must always be kept in mind when reviewing ancillary equipment of aircraft.

The vote of thanks was carried with acclamation and the meeting closed.

ABSTRACTS FROM THE SCIENTIFIC AND TECHNICAL PRESS.

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(Prepared by R.T.P.)

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Soviet Air Force—Parachutes. (U.S. Nav. Inst. Proc., Vol. 65, No. 440, Oct., 1939, p. 1513.) (72/1 U.S.S.R.)

The Russian press recently announced that two designers have been rewarded for making a semi-automatic instrument for opening parachutes during a jump. No technical details are given, except that, working on the principle of clock mechanism, it ensures that the parachute will open at a given height set before the jump. It is claimed that the instrument has undergone exhaustive tests, including one in which the parachute opened at a height of some 2,000 ft., having been released with a dummy at 18,000 ft.

Some Experiments on the Penetration of Projectiles. (P. Regnauld, Mem. de l'Art. Française, Vol. 17, 1938, pp. 731-772. Z.G.S.S., Vol. 34, No. 10, Oct., 1939, p. 288.) (72/2 France.)

The projectile used for these experiments was of 13.2 mm. calibre, with brass coating and steel core. Both the velocity and the hardness of the core of the bullet could be varied. The penetration into an unlimited quantity of dry sand is practically constant (25 cm.) for any muzzle velocity beyond 400 m./sec. At 800 m./sec., however, the bullet will pass readily through a wall of sand of double this thickness (50 cm.).

Firing into a lead block yielded similar results. In the case of a lag block the penetration (22 cm.) is again independent of muzzle velocity above 500 m./sec. The perforation depth at 800 m./sec. is now, however, only 25 cm.

Hardness of bullet core governs penetration of steel, the softer bullet spreading on impact and being reflected. In the case of aluminium plates, however, the hardness of the bullet has but little effect on penetration. It is interesting to note that at 800 m./sec. the penetration is of the order of 5 cm. for mild steel (hard core bullet) and a double this for cast aluminium. It appears that each material has a limit of maximum penetration which cannot be exceeded, however great the impact velocity except by increasing the mass of the bullet.

Air War in Poland. (F. Latsch, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., pp. 240-242.) (72/3 Switzerland.)

At the beginning of the war, Poland disposed of approximately 1,000 aircraft, of which three-quarters were fighters and reconnaissance and one-quarter bombers.

The major part of this force never left the ground since the Germans from the start of hostilities undertook the systematic destruction of all aerodromes within reach of the frontier together with their ammunition and fuel supplies.

Having achieved command of the air (the Polish A.A. fire being ineffective without fighter co-operation) the lines of communication of the Western Polish armies were destroyed systematically and their retreat hampered. In this connection, the heavy fighter No. 110 (20 mm. cannon) was used against locomotive (perforation of boiler), the standing trains being subsequently destroyed by dive bombers.

All these attacks were preceded by a detailed photographic study of the position so that the target of importance could be selected.

Special reference is made to the utilisation of a group of Fieseler-Storch slow speed aircraft for the bombing of a wood held by the Poles and thus opening a way for the German tanks.

Air Operation in the Civil War. (W. M. Graf, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., 1939, pp. 244-246.) (72/4 Switzerland.)

The author served for 2½ years with the Republican A.A. Artillery and some of his conclusions are of interest :—

1. The 20 mm. Oerlikon gun gave trouble with the glycerine recoil brake, due to the large differences in day and night temperatures. This prevented the gun being used at elevation above 70°.

2. The German guns had a higher rate of fire (35 against 22 per minute). The Oerlikon guns were completely worn out after 3,000 rounds.

3. The German gunners concentrated the fire on the leading aircraft and did not generally put up a barrage.

4. Toward the end of the war, bombing attacks were carried out in open formation. German operations were always preceded by most detailed photographic reconnaissance.

5. Junkers 86 K and Fiat C.R. 32, the latter fitted with 11 mm. Breda machine guns, are specially mentioned as being efficient.

6. Speaking generally, the Italian airmen were more aggressive than the Germans, but not so well organised.

General Mathematical Considerations on the Errors Associated with A.A. Fire. (H. Brandli, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., 1939, pp. 247-248.) (72/5 Switzerland.)

If the gun setting remains constant in elevation and azimuth, successive projectiles will follow the same trajectory.

If, however, the gun elevation varies during the firing, the locus of all the projectiles in space at a given instant will be a new curve which intersects the trajectory associated with each elevation. If the rate of fire during the steady motion of the gun is high enough, there will then be an almost continuous string of projectiles travelling outwards from the gun like ripples on a pond. The "age" of these projectiles reckoned from the time they left the gun will vary along this locus, projectiles of the same age lying approximately on the same arc of a circle with the gun as centre. The arc corresponding to the time fuse setting on the projectile will determine the position of successive shell bursts. The projectile position locus clearly terminates at the burst and the string of projectiles spreading outwards from the gun thus gradually shortens, *i.e.*, the angle subtended at the gun finally vanishes. If thus the angle of elevation of the gun is increased during the fire, low flying aircraft at a distance corresponding to the fuse setting will be endangered by the shell burst whilst at the same time aircraft passing over the gun position at a medium altitude are subject to a direct hit. The author hopes to give numerical examples in a subsequent article.

Acoustical Range Finding (Artillery Spotting). (R. Sanger, Zurich, 1938. Original available in R.T.P. (continued). (72/6 Switzerland.)

The author develops the differential equations of the curved sound rays in the practical case and obtains a solution under the simplifying conditions of constancy with altitude of wind and sound velocity gradients.

A closer approximation to practical conditions may, however, be obtained by assuming a homogenous wind undergoing periodic variations in velocity which are propagated at a definite speed. In this way some allowance is made for atmospheric turbulence. Fluctuation in wind speed cause periodic changes in the recorded time intervals between the reception signals of consecutive muzzle explosions. These changes may amount to 1/100 sec. and the resultant position error varies inversely as the base length. If this error is to be kept within 1 per cent. of the distance, a base length of at least 500 m. must be used.

When the absolute distance of the gun is not known with sufficient accuracy it may be necessary to duplicate the installation and thus obtain two possible asymptotes, the intersection of which fixes the distance to the required degree of accuracy. In this case care must be taken that the base lines of the two stations do not overlap.

When sound ranging for gun positions the time interval of the sound of the muzzle explosion reaching two receivers placed at the ends of a base line is measured.

Assuring that the atmosphere is homogeneous and is entropic (velocity of sound independent of direction and position of source), the locus of the source is a rectangular hyperbola of which the two receivers are the foci. The direction ϕ of the asymptote with the base is given by

$$\cos \phi = \pm C\,(\Delta t/b)$$

where C = velocity of sound.

Δt = observed time interval.

b = length of base.

The direction of the sound source with regard to the base will approximate closely to the direction of the asymptote for large distances and can be obtained with sufficient accuracy by rotating the asymptote through a small angle depending on the distance of the gun. In practice matters are complicated by the fact that the atmosphere is not homogeneous and that a wind is generally present.

Radio Controlled Target Plane. (Sci. Am., Vol. 161, No. 5, Nov., 1939, p. 288.) (72/7 U.S.A.)

The small target monoplane has 12-foot wing span with pronounced dihedral. The estimated ceiling is 5,000 feet. Two propellers are driven in opposite directions by a single air-cooled petrol engine. The plane is launched by means of a catapult and its subsequent flight controlled by radio. A parachute is fitted which is ejected as soon as the engine stops and controls the rate of descent of the plane. This parachute can also be released by wireless from the ground. The advantages claimed for such a target plane are the small cost of construction and ease of repair and maintenance. Since an aerodrome is not required either for landing or take-off, shooting trials can be held in any locality otherwise suitable.

Photographs show the plane in position on the catapult and packed for transport on a motor car.

The device is undergoing test by the Army Air Corps (U.S.A.) at the Wright Field, Dayton.

Study of Axial Flow—Air Propellers. (M. F. Dowell, Gen. Elect. Review, Vol. 42, May, 1939, pp. 210-7. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 89.) (72/8 Great Britain.)

The author has made a comparative study of (1) small-axial-depth, narrow-bladed propellers, and (2) large axial-depth wide-bladed propellers. The air-flow was observed by photographing wisps of smoke entrained in the air-currents. A very large quantity of concentrated light is necessary, because the smoke tends to thin out quickly. An ultra-high-speed motion-picture camera was used. Dull black backgrounds and flat white reflecting surfaces for the parts in motion yield the best results, and speeds ranging from 1,000 to 1,200 pictures per sec. are sufficient. The pressure and velocities of the stream were studied by means of a pitot-tube arrangement. One or more sources of stroboscopic light were used for visual observations of smoke-flow through propellers. A one-segment commutator attached to the shaft of the driving motor flashes the light at predetermined positions of the rotating propeller, thus causing the elements to appear stationary. In order to find the sources of noise, a very small exploring crystal microphone with a low vibration-response was placed directly on the blade and rotated with it, the connections being made by mercury cups. Metallic vibration or blade-resonance must be avoided by covering the blades with rubber and cushioning the spindle. The results indicate that a wide-blade large-axial-depth propeller gives less vortex-formation and less noise than does a narrow blade.

Measurement of Pressure Variations in the Neighbourhood of a Full-Size Air-screw Blade. (J. Obeta, Y. Yosida, U. Yosida, Aero. Res. Inst., Tokio, Report No. 179, July, 1939.) (72/9 Japan.)

Previous experiments by the authors were confined to model propellers ($\frac{1}{3}$ and $\frac{1}{4}$ full scale).

The present measurements were carried out on a full-scale 3 bladed aluminium alloy propeller, 2.9 m. diameter, driven by an electric motor. For most of the experiments, the blade angle at $\frac{3}{4}$ radius was reduced from its normal value of 26° 50′ to 12° in order to obtain supersonic tip speeds at a relatively small power expenditure. The measuring microphone was only 14 mm. in diameter, the pressure variations being explored along straight lines at a distance of 18 cm. and 11 cm. from the front and rear of the longitudinal axis of the propeller blade. Records were also obtained in the plane of rotation and at several points perpendicular to this plane up to a maximum distance of 50 cm.

The oscillograph records show the time variation of the pressure at a fixed point. From this it is possible to reconstruct the pressure distribution relative to the propeller blade. Whilst in the small model experiments maxima of both pressure and suction coincided with blade position, in the case of the full scale propeller travelling at supersonic tip speed, maximum pressure lags considerably behind the blade position on the front side, but agrees on the rear side of the blade. By extrapolating the law of pressure variations with distance, the pressure distribution over the rotating blade can be estimated. The results obtained so far, only give agreement with the measured thrust in certain cases (low speed). It is hoped to investigate this more fully by improvements in the microphone (absolute calibration; slip-stream shield) and repeating the experiments at a much smaller distance from the rotating blade so as to make the extrapolation more certain.

Forces and Moments on a Yawed Aerofoil. (S. Hoerner, L.F.F., Vol. 16, No. 4, 20/4/39, pp. 178-183. N.A.C.A. Tech. Memo. 906, August, 1939.) (72/10 U.S.A.)

The existing experiments with straight wings (zero dihedral), wings with dihedral, and wings with sweepback are evaluated within the range of sound angles of attack, explained by calculations and generally enlarged.

1. The total forces (c_a and c_w) are practically unaffected by yaw (up to $\tau \approx 25°$). The newly appearing lateral force is derived for wings with and without dihedral.

2. The rolling moments due to yawing which exert a righting effect on straight aerofoils (zero dihedral) in contradiction to the calculations made up to the present, are explained by a corner effect, an edge effect, and by the dissimilar yawed flow of the two wing-halves. The known wind-tunnel experiments are given in diagram form so that the rolling and yawing moments can be read off.

3. Dihedral produces subsidiary rolling and yawing moments due to yaw. The calculation of the rolling moment is confirmed by measurement.

4. The yawing moments due to sweepback were computed. Both yawing and rolling moments are confirmed by measurement.

5. Since the yawing moments due to yaw are often very small, considerably greater instrumental accuracy is required in order to achieve agreement between calculation and measurement.

Laminar Friction Resistance with Pressure Gradient. (E. A. Wright and G. W. Bailey, J. Aeron. Sci., Vol. 6, No. 12, Oct., 1939, pp. 485-488.) (72/11 U.S.A.)

From the Karman Momentum theory it follows that in the case of a pressure gradient $\frac{dP}{dx} = -\rho U \frac{dU}{dx}$ the local coefficient of friction c_f is given by

$$c_f = 2\left(\frac{d\theta}{dx}\right) + 2\theta\left(2 + \frac{\bar{\delta}}{\theta}\right)\left(\frac{1}{U}\right)\left(\frac{dU}{dx}\right)$$

when θ = momentum thickness of laminar boundary layer.
$\bar{\delta}$ = displacement thickness of laminar boundary layer.
U = potential floor velocity outside boundary layer.

The authors carried out experiments in a special boundary layer research tunnel using a flat plate under conditions of positive and negative pressure gradients. The results show that over this range of gradients employed

$$\frac{2\theta}{x} = 1.328/(u_x/\nu)^{\frac{1}{2}}\ \bar{\delta}/\theta = 2.59 = \text{constant}.$$

Substituting in the Karman equation above, we obtain

$$c_f = .664/(u_x/\nu)^{\frac{1}{2}}\left[1 + 8.18\,\frac{x}{U}\frac{dU}{dx}\right]$$

which includes the effect of pressure gradient over the range investigated.

The University of Washington 250 m.p.h. 8 × 12-foot Wind Tunnel. (F. K. Kirsten and F. S. Eastman, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 494-498.) (72/12 U.S.A.)

The tunnel is of the Venturi closed throat double return type, each duct being provided with a 500 h.p. propeller.

Extra electric motors can be coupled to these propellers, so that a further increase in speed to 320 m.p.h. will be possible in the future.

Chief interest attaches to the six component balance, which has been designed so that readings can be obtained quickly and the model easily changed. A set of 15 readings can be taken in 3 to 5 minutes. Thus 4 or 5 sets of readings at different angles of attack can be obtained in 15 minutes when investigating yawing stability. Electrical recording is used throughout and simultaneous readings of all 6 components, dynamic pressure, angle of attack, angle of yaw, time, air temperature and barometer can be obtained by photographing the instrument panel, or recording milliameters can be used.

The drag of the mounting fork is less than 25 per cent. of the minimum drag of a representative aerofoil. Flexure pivots designed by Eastman (J. Aeron. Sci.,

Vol. 5, No. 1, Nov. 1937, pp. 16-21) are used in the suspension system and forces ranging from 25 to 2,500 lb. can be measured to the same accuracy of 1 per cent.

A Flight Investigation of the Distribution of Ice-Inhibiting Fluids on a Propeller Blade. (L. A. Rodert, N.A.C.A. Tech. Note No. 727, Sept., 1939.) (72/13 U.S.A.)

The flow of ice-inhibiting fluids over the blade surfaces of a 12.5 foot diameter propeller was investigated in flight by discharging dyed fluids at various stations along the leading edges of the blades. The effects on the distribution of varying the fluid composition, the blade-surface roughness, and the orifice design were also observed.

The flow patterns obtained indicated that, under favourable combinations of type of fluid, surface smoothness, and orifice design, the fluid would flow from an orifice near the propeller hub along the leading edge to about the 40-inch blade station (53 per cent. of the blade radius). The fluid would not flow along the leading edge beyond the 40-inch station regardless of orifice location.

Fluids consisting of 85 per cent. alcohol and 15 per cent. of either glycerine or ethylene glycol flowed farthest along the leading edge. Decreasing the percentage of alcohol decreased the percentage of the blade length covered by the fluid. Discharging the fluid from an orifice that spread the fluid out in a thin film in intimate contact with the blade increased the blade area coverage of a given volume of fluid. Surface roughness of the blade reduced the radial distribution.

Wind Tunnel Investigation of an N.A.C.A. 23021 Aerofoil with Two Arrangements of a 40 per cent. Chord Slotted Flap. (F. Duschik, N.A.C.A. Tech. Note No. 728, September, 1939.) (72/14 U.S.A.)

An investigation was made in the N.A.C.A. 7 by 10 foot wind tunnel of an N.A.C.A. 23021 aerofoil with two arrangements of a 40 per cent. chord slotted flap. The effect of slot shape, flap position, and flap deflection on the section aerodynamic characteristics was determined. The envelope polars and the section aerodynamic characteristics are given and are compared with those of an N.A.C.A. 23021 aerofoil with a 25.66 per cent. chord slotted flap and of an N.A.C.A. 23012 aerofoil with a 40 per cent. chord slotted flap. Plotted contours of flap-nose positions for maximum lift and minimum drag were used for selected optimum conditions.

Both the maximum lift coefficients and the minimum drag coefficients were higher for the N.A.C.A. 23021 aerofoil with the 40 per cent. chord flap than for the N.A.C.A. 23021 aerofoil with the 25.66 per cent. chord flap, but the percentage increase in drag was greater than the percentage increase in lift. A comparison of the aerodynamic characteristics of the N.A.C.A. 23021 aerofoil with a 40 per cent. chord flap and of the N.A.C.A. 23012 aerofoil with a 40 per cent. chord flap showed that the thick section reached approximately the same maximum lift as the thin section but, as anticipated, had a considerably higher drag coefficient.

Aeroplane Demagnetisation and Neutralisation. (J. G. Lee, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 489-493.) (72/15 U.S.A.)

Sources of magnetic disturbance in aircraft, when located, can be eliminated by demagnetisation (by means of an alternating current) or by neutralisation (reducing magnetic strength by application of a suitable direct current coil).

As a general rule, compact bodies or long slender parts are best demagnetised. Complex structures of large dimensions or small integral parts of a large unit are best dealt with by neutralisation.

Experience gained by the Chance Vought Aircraft Company shows that the neutralisation correction is permanent, provided it is applied after the aircraft has been in operation for at least one hour (material shaken down).

Much subsequent trouble can be saved by previous demagnetisation of all raw material and a systematic check of finished assemblies and employing as far as possible non-magnetic material in the neighbourhood of the compass. In this connection stainless steel is preferable to chrome-molybdenum.

The Grant Streamline Flap. (W. L. Nye, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 502-504.) (72/16 U.S.A.)

The Grant Flap consists of two or more slotted parts by means of which the curvature of the rear portion of the wing can be gradually increased, the slots preventing break away of the flow. It is stated that maximum lift coefficients of the order of 3 are obtainable using wing profile N.A.C.A. 23012, the minimum drag coefficient being as low as .012. No details of the flap operating mechanism are given.

Normal flap operation impairs aileron control. In the case of the Grant flap, it is suggested to overcome this difficulty by having outer flaps to act as ailerons, the deflection of which is only $\frac{1}{2}$ that of the main inner flaps. Due to the slotted nature of the flap, good lateral control is maintained in spite of large inner flap deflection.

Design and Shop Problems in High Pressure Hydraulic Systems on Aircraft. (H. W. Adams, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 14 (Digest).) (72/17 U.S.A.)

High pressure systems employ oil pressures in excess of 2,000 lb. per sq. in. and this leads to an important saving in weight of the installation (600 lb. in the case of the D.C.4 aircraft). The reduction is mainly associated with the weight of pipe lines, whilst the pump (which now has to be of the piston type) comes out slightly heavier than the low pressure vane or gear type. High pressure systems present no serious production problems, since the closer tolerances required are made easier to obtain by the greater wall thickness. Installation and servicing is simpler since all the parts are smaller.

Danger in the event of failure is about the same for high and low pressure systems.

Trans-Atlantic Aeroplane Design. (R. J. Nebesar, J.S.A.E., Vol. 45, No. 5, November, 1939, pp. 478-484.) (72/18 U.S.A.)

After reviewing the leading characteristics of large American land and sea planes, including projects such as the Sikorsky S.47, the author presents details of two land plane projects each of app. 50 tons gross weight worked out by the Avia Company of Prague. In these designs the passengers are housed inside a bulge over the central section of the wing, somewhat on the lines of the Burnelli Aircraft. The tail surfaces are carried on two separate booms. It is claimed that this arrangement reduces drag and increases lift. Detailed performance estimations are given and the flying cost for the Paris—New York trip is reckoned as low as 167 dollars per passenger (29 passengers carried).

An Aerodynamic Power Plant. (J. Ackeret and C. Keller, Schw. Bauzeitung, Vol. 113, May, 1939, pp. 229-30. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 102.) (72/19 Germany.)

The authors discuss a new system of power generation which is undergoing trials. The circuit is a gas circuit in which air is utilized as the gas (other gases can be used) and the circuit, unlike that of the ordinary gas-turbine process, is a closed circuit comprising gas-heater, preheater, regenerator, compressor, and turbine. A formula is given for the heat-efficiency of the ideal cycle, i.e., without taking into account the losses in the turbine compressor, gas-heater, and preheater. With this system the thermal efficiency can be improved without increasing the pressure, as in the case of steam plant, with its consequent complication in design

and necessity for safety-devices. The exhaust air from the turbine flows through the regenerator and yields up its heat to the air flowing from the compressor to the gas-heater. The regenerator air is further cooled, so that the compressor takes in cold air. The cooling-water process forms only a small item in comparison with a steam plant, and no special attention to the quality of the water is necessary.

Development of High Duty Motors—Especially of Aero Engines. (F. Jaklitsch, Autotech. Z., Vol. 42, 25/5/39, pp. 273-87. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 87.) (72/20 Germany.)

The author considers that a new stage in the development of aero engines is at hand, in which units ranging up to 2,000 h.p. are being considered. The fundamental factors governing design are therefore being explored energetically in many quarters. A comprehensive discussion, based upon statistical data, of the effects of the leading dimensions is presented. The stroke/bore ratio for a number of aero engines and diesel road motors is examined and it appears that in most cases the power per litre falls as the stroke/bore ratio increases: all of the comparisons are made in respect of engines by the same maker. The author suggests as the best relation: H.P. $\propto \sqrt{}$ (Bore $\div$ Stroke), and emphasizes the need in rating an engine for specification or duration. Denoting by Pt, P_1, and P_{100} the power-output over t minutes, 1 minute, and 100 hr. respectively he derives the relation $t = \{ (N_1 - N_{100})/(N_t - N_{100}) \}^3$. The cost of production is discussed in detail and is plotted in terms of total horsepower and of type; the cost decreases as the number of cylinders increases, and the radial engine appears to be the cheapest form. The author emphasizes the importance of drag resistance, in regard to which the radial engine is not the best type.

Aircraft Engine Research of the National Advisory Committee for Aeronautics. (C. Kemper, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 479-484.) (72/21 U.S.A.)

The major part of the work has been concerned with fuel injection for spark ignition engines and with improvements in the finning of air-cooled cylinders.

Fuel Injection.—The power output of a standard air-cooled cylinder can be increased 10-15 per cent. at the same specific fuel consumption by replacing the carburettor by an injection pump. The increase in power is almost entirely due to increased volumetric efficiency. A further advantage of fuel injection is the possibility of using "safety" fuels, certain of which, when doped, give the same power and consumption as iso-octane.

Finning.—The N.A.C.A. have increased the finning of a conventional cylinder head six times by using preformed sheet aluminium fins bonded to the cast head. At the same time the finning of the barrel has been increased three times by brazing sheet steel and copper fins to the barrel. By this means it was found possible to increase the indicated power output three times over that of conventional designs for the same cooling pressure drop across the cylinder (3 in. to 10 in. water) and the same mean temperature difference between head and cooling air (300°F.).

Piston Temperatures under running conditions have been measured, using thermocouple embedded in the piston connection with a potentiometer being made for about 10° of crank angle at the bottom of the stroke using pneumatically operated plunger contacts.

The following average temperatures were obtained on a conventional air-cooled cylinder operating under normal conditions.

Head temp. (average of 22 couples) ...	325°F.
Barrel temp. (average of 10 couples) ...	260°F.
Piston skirt (one couple)	275°F.
Piston crown (average of 3 couples) ...	450°F.

Of interest is the small temperature difference between barrel and skirt. As all the piston temperatures can be lowered by lowering the barrel temperature increased finning on the barrel is logically indicated.

DIESEL RESEARCH.—A single cylinder four-stroke, boosted air-cooled Diesel (5 in. bore, $5\frac{1}{2}$ in. stroke) using the displacer type of combustion chamber has been developed. Minimum specific fuel consumption (.36 lb.) is obtained at b.m.e.p. of 100-120 lb. per sq. in. For take-off, the b.m.e.p. can be increased to 170 lb. per sq. in. (specific consumption .48 lb.). The estimated weight of a 9 cylinder radial would be 10 per cent. more than that of the corresponding spark ignition engine.

It is however thought that the most promising design for aircraft work will be a two stroke fitted with mechanically operated valves (possibly some form of sleeve valve mechanism).

Problems of Submerged Engine Installations. (W. E. Beall and E. G. Emery.) *Propeller Requirements for Submerged Engine Installations.* (G. W. Brady, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 21 (Digest).) (72/22 U.S.A.)

Placing the engine inside the wing makes a heavier and more costly installation. Accessibility is reduced and the possibility of endangering the primary structure of the aircraft in case of engine or propeller failure is increased. The only advantage is the possibility of increased aircraft speed, and in the opinion of the author this does not outweigh the disadvantages listed above. In several cases, the expected increase in speed with submerged or partly submerged engines was not realised in practice and it is rather significant that the German Heinkel aircraft holding the world's speed record had a short cylindrical cowl with no propeller shaft extension.

In the submerged installation, special attention must be paid to propeller hub drag. Fairing of the blade shanks will save 90 h.p. at 400 m.p.h. and over 300 h.p. at 500 m.p.h. in the case of a 1,200 h.p. propeller.

Incidentally this fairing is already adopted on standard engine installations and in the case of radial engines will not only reduce the drag but improve the cooling of the engine.

Petrol Injection or Carburettor? (C. Mazzuchelli, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., 1939, pp. 254-6.) (72/23 Switzerland.)

The main disadvantage of the present day aero-engine carburettor is the icing danger. This is best overcome by placing the carburettor behind the blower and utilising special fuel pumps capable of overcoming the increased induction air pressure. This also reduces fire risk, since the high speed air from the blower prevents flame egress due to back-fire.

In most modern carburettors, the float chamber has been replaced by a diaphragm and the attitude of the aircraft is therefore no longer of any consequence.

The problem of petrol injection is entirely one of a suitable pump. Whilst certain specialist firms are capable of turning out satisfactory pumps, there is no doubt that servicing and maintenance of such instruments is more difficult than that of a carburettor.

Apart from distribution, there is no evidence that either power or specific consumption can be improved by adopting petrol injection, provided of course the comparison is with a first-class carburettor installation. Timed injection however renders possible internal cylinder cooling by air scavenging and also brings in the 2 stroke petrol engine as an alternative line of development.

Summing up, the author is of the opinion that a change-over on existing plants employing pressure carburettor is scarcely worth while, but that petrol injection must be seriously considered in any development work or new designs.

Results of Investigations on Used Lubricating Oil Taken from the Maybach Motors of the Three-Coach Diesel Trains of the Netherlands Railways. (H. L. Matthijsen, De Ing. (Verkeerswezen), Vol. 54, 16/6/39, pp. 31-5. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 113.) (72/24 Germany.)

The author gives the results of investigations of the quantity of fuel-oil absorbed by the lubricant, the quantity and the character of the sludge formed in the lubricant, and the quantity and origin of the iron found in the sludge. In his conclusions, he states that in the Maybach motors the lubricant absorbed very little fuel-oil. The sludge consists largely of blow-by carbon originating in the fuel. The design of the fuel-sprayers has considerable influence upon the sludge-content, which, for sprayers having five orifices, was four times that with sprayers having four orifices. The average iron-content of the sludge was 3 per cent., consisting principally of very fine particles detached from the roller bearings. Increase in speed caused deterioration in the lubricant, which aged more intensively owing to the higher temperatures in the motors, whereby the viscosity and the sludge-content were increased.

Mixture Distribution and Volatility. (L. A. Peletier, J. L. Tops, W. J. Heeckeren, Airc. Eng., Vol. 11, No. 129, Nov., 1939, pp. 407-10.) (72/25 Great Britain.)

Conclusions.—1. The relation between mixture distribution in the Wright Cyclone engine and fuel volatility was found to be much more complex than had so far been generally presumed.

2. The experiments have not led to conclusive evidence as to what is the best volatility to be used.

3. There would seem to be two conditions at which an ideal distribution could be obtained:—

(*a*) When complete immediate evaporation takes place in the carburettor and the impeller is being fed with a homogeneous vapour-air mixture.

(*b*) When no evaporation takes place between the carburettor and the impeller the latter serves as distributing agent for the liquid.

4. The deflection of the mixture between carburettor and impeller is the main cause of distribution irregularities when neither of the ideal cases obtain.

5. All the above considerations do not touch upon the subject of the degree of wetness and homogeneity of the charge in the cylinder and the possible effects thereof on engine performance.

Investigations of Vapour Lock in Aircraft Fuel Systems. (O. C. Bridgeman, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 21 (Digest).) (72/26 U.S.A.)

Vapour lock usually occurs at the fuel pump inlet or at the carburettor, these being the points at lowest pressure in the fuel system. The difficulty becomes especially pronounced at altitudes above 20,000 feet. For any given fuel, the following remedies are suggested:—

1. Low pressure drop in fuel system.
2. Elimination of heat in neighbourhood of system.
3. Fuel coolers.
4. Pump design.
5. Short fuel lines, sloping continuously back to the tank.
6. Supercharged system (tank, pump and carburettor under pressure).

Integral fuel tanks in the wing help to keep the fuel cool provided no hot exhaust gases are in the neighbourhood. It must always be remembered, how-

ever, that the fuel in such tanks will not cool rapidly after leaving the ground, and separate coolers may still be necessary.

No information is available as to whether the cooled fuel precipitates carburettor icing.

Recent Developments in Diesel Lubricating Oils. (G. L. Neely, J.S.A.E., Vol. 45, No. 5, Nov., 1939, pp. 485-500.) (72/27 U.S.A.)

Development and service properties of a new compounded Diesel-engine lubricating oil are described in this paper. Properties of the oil brought out by the author include anti-ring-sticking value; prevention of lacquer formation; reduction of carbonaceous deposits; that it is non-corrosive to all types of bearing metals; and that it reduces piston-ring and cylinder wear at both high and low temperatures. Although recommended specifically for Diesel engines, the oil is also suggested for petrol engines, particularly where engine deposits are troublesome.

A fundamental property of lubricants is described which relates to the highest temperature at which an oil will wet a metal surface with a fluid film of sensible thickness. Data are presented showing that engine scuffing difficulties are prevented by lubricants having good spreading properties at high temperatures, and that the new lubricant possesses superior spreading characteristics to which its breaking-in and surface-conditioning properties are attributed.

The comparative economics of engine operation with this new type of lubricant and straight mineral oils is discussed. Application of the oil for cleansing or purging of both Diesel and petrol engines is explained.

ABSTRACTOR'S NOTE.—From the discussion it appears that the compounded lubricating oils recommended by the Author have not worked satisfactorily in petrol engines. Deposits of Ca Sulphate, which lead to detonation troubles, are likely to form in the combustion chamber.

Is There a True Creep Limit? (U. Dehlinger, Z. fur Metallk, Vol. 31, No. 6, June, 1939, pp. 187-191. In course of translation.) (72/28 Germany.)

The true creep limit is defined as the limiting load below which there occurs no further deformation (plastic or elastic) however long the load is applied. The creep limit at a small but finite rate of deformation is necessarily higher than this.

From thermodynamic considerations the author concludes that in the absence of any chemical change the maximum deformation S corresponding to a given load K must satisfy the condition

$$K = \frac{\delta E}{\delta S},$$

where E is the elastic component of the total energy of deformation. The creep limit is thus given by the maximum value of $\frac{\delta E}{\delta S}$ as a function of S. In the case of a homogeneous single crystal, subjected to shear, tension or compression, $\frac{\delta E}{\delta S} = O$. The crystal thus begins to flow under the smallest load and there is no creep limit.

In the more general case of a multi-crystalline substance, flow is necessarily accompanied by a deformation of the grains, $\frac{\delta E}{\delta S} \pm O$ and a creep limit must exist, provided there is no re-crystallisation.

For amorphous substances such as glass, the flow can produce a rotation of the volume elements and no true creep limit exists.

From a review of data it appears that the ultimate strength under fatigue approximates to the true creep limit, at any rate in the case of coarse grained substances.

Combined Beam—Column Stresses of Aluminium—Alloy Channel Sections. (R. Gottlieb, T. M. Thompson and E. C. Witt, N.A.C.A. Tech. Note No. 726, September, 1939.) (72/29 U.S.A.)

The test specimens were extruded 24ST aluminium-alloy channel sections 2.1 inches wide and 0.1 inch thick with legs (or flanges) varying from approximately 0.5 inch to 2 inches in depth.

The results of the tests of about 70 specimens were graphed for stresses due to axial load and stresses due to bending load as functions of length to radius of gyration of the specimens. From these graphs a design chart suitable for ready use was derived.

Metal Sprayed Bearings for High Speed Operation. (H. Shaw, Power Transmission Vol. 8, May, 1939, pp. 213-221. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, pp. 113-4.) (72/30 Great Britain.)

In a paper read before the Association of Metal Sprayers, the author describes tests made at both low and high speeds (1,000—3,000 r.p.m.) and with loads ranging up to 8,000 lb. per sq. in. Results for Babbitt metal, a cadmium-silver-copper alloy, bronze, and lead-bronze are tabulated and plotted in curves. Further tests are in progress with sprayed aluminium bearings.

Fatigue Machines for Testing Structural Units. (R. L. Templin, Amer. Soc. Test. Mater. Preprint No. 41, 11 pp., June, 1939. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, pp. 114-5.) (72/31 U.S.A.)

The machines described are for the purpose of making fatigue tests upon structural units such as joints, beams, columns, and frames. The largest, which has a maximum capacity of 22.3 tons in tension or compression, consists of a horizontal beam, one end of which is connected through a vertical member to the bed-plate, whilst the other is capable of being oscillated by means of an eccentric crank. The test-specimen is placed in the centre of the beam. A maximum of 312 cycles per minute may be obtained, and the amplitude is variable. The author also describes two other machines for testing riveted joints, which work on similar principles, but at speeds ranging up to 300 or 500 cycles per min. Micro-limit switches are provided so that a change in deflexion of a few thousandths of an inch will shut down the machine when the specimen fails. The calibration of the beams is described. The dial-gauges record deflexions to 0.0002 in. The loads are obtained from the deflexions of the beam. Details of some of the joints tested are given. About 400 specimens which have been tested exhibit a marked consistency. The results obtained have indicated changes that should be made in the design of joints for structures.

An Investigation of the Fretting Corrosion of Closely-Fitting Surfaces. (G. A. Tomlinson, P. L. Thorpe, and H. J. Gough, J. and Proc. Inst. Mech. Eng., Vol. 141, May, 1939, pp. 223-37. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 99-100.) (72/32 Great Britain.)

The authors describe experiments upon the mutual corrosion of metal surfaces in closely-fitting contact when subject to vibration. They demonstrate that the corrosion is mechanical rather than chemical in character. Lubricants modify, but do not prevent corrosion. The mechanism of the phenomenon is discussed, and the authors suggest that it is due to a process of molecular attrition, possibly closely associated with fatigue effect.

X-Ray Stress—Measurements in Tensile Specimens of Carbon Steel. (F. Bollenrath, V. Hauk, and E. Osswald, Z.V.D.I., Vol. 83, 4/2/39, pp. 129-132. Eng. Absts., Vol. 2, No. 8, Section 1, August, 1939, p. 70.) (72/33 Germany.)

The authors describe experiments made to study the stress-decrease in bending specimens when loaded beyond the yield-point. Tensile specimens of square cross-section were used, and measurements were made, mechanically and by means of X-rays, of the deformations occurring with elongations ranging up to 11 per cent. It was observed that as the yield-point was exceeded the stress-distribution over the cross-section became markedly non-uniform, with internal compression stresses near the boundaries; approximately half the cross-section appeared to be in compression, and the inner half in tension. In order to eliminate dimensional effects, specimens of 17.32 mm., 16.34 mm., and 11.82 mm. square section were used. The central zone for gauging was 140 mm. long, and from the gauge-length, gently tapering lengths of 150 mm. were used to cut out any possible constraint from the grips. Up to the yield-point the stresses deduced by X-ray calculation agreed very precisely with those deduced mechanically from load and cross-section. The authors suggest that the results are of considerable importance in the general study of plasticity, in which stresses actually occurring are very different from nominal stresses. The results indicate also that the crystal frame constant varies with depth from the surface, i.e., from 2.86054 to 2.86136 over a depth of 1 mm.

X-Ray Measurement of Stress in Endurance Testing. (G. Kemmnitz, Z. Tech. Phys., Vol. 20, May, 1939, pp. 129-40. Eng. Absts., Vol. 2, No. 8, Section 1, Aug., 1939, pp 70-1.) (72/34 Germany.)

The author presents the results of an X-ray determination of internal notch stress during testing under alternating stress at 3,000—1,500 r.p.m. of a cross-pierced shaft, and at the fashioned fillet of a test piece. A steel having a nominal yield-point of 25-30 kg. per sq. mm. (16-19 tons per sq. in.) was carefully turned down, the last millimetre being removed by abrasive blocks, annealed *in vacuo* in Jena glass, and investigated with Coradiation, at $\lambda = 1.785$ Å, from a Muller tube operating at 53 kV. and 5 mA. Removal of the outer surface by etching was found to be unnecessary. For this material a Wohler-curve value of 14 kg. per sq. mm. (9 tons per sq. in.) was obtained on the Schenk machine. For loads considerably above the endurance-limit, fracture was normal to the axis, whilst for loads nearer the endurance-limit the more normal type at less than 45 degrees occurred. No special improvement was observed on applying the load in steadily increasing amounts. From experimental results it appears that peak notch stresses are completely elastic until a crack actually sets in, when they sink simultaneously, both statically and dynamically. By separate evaluation of load and internal stress during torsion, it is shown that in the direction of tension flow occurs even below the yield-point; this explains the behaviour of service stresses during dynamical loading and the preponderance of internal pressure stresses following alternating load.

Distortion of a Curved Tube Due to Internal Pressure. (W. R. Dean, Phil. Mag., Vol. 28, No. 189, Oct., 1939, pp. 452-64.) (72/35 Great Britain.)

An approximation to the distribution of stress in a curved tube caused by a uniform internal hydrostatic pressure is already known, but the determination of the displacement presents more difficulty, since the method that gives correctly an approximation to the stress fails to produce a corresponding approximation to the displacement.

In the present paper some progress is made with the determination of the displacement; a method of successive approximation is used, and the work is carried far enough to find the part of the displacement that is of most interest physically. The stress corresponding to this part of the displacement is compared with the known approximate result, and the two are shown to agree to the correct order of approximation.

Magnitude of the Direct Stress in a Beam of Fixed Span. (R. J. Cornish, Phil. Mag., Vol. 28, No. 189, Oct., 1939, pp. 481-7.) (72/36 Great Britain.)

When a beam, simply supported at two points, is deflected, the points of support must approach one another slightly, since the length of the neutral axis remains constant. If the beam has fixed " pin-jointed " ends or built-in ends, longitudinal movement is prevented, and a direct stress is developed in the beam. The author obtained general expressions for this stress in four representative cases and the probable maximum values of the stress are deduced for steel and reinforced concrete beams. It appears that with beams of steel and reinforced concrete as at present designed the direct stress is small compared with the bending stress.

Notes on Recent Structural Research at Goodyear—Zeppelin Corporation. (K. Arnstein and E. L. Shaw, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 499-501.) (72/37 U.S.A.)

A practical type of model girder has been developed which permits the axial, bending and torsional elastic constants to be varied independently. Means for the convenient and accurate measurement of corresponding strains and stresses have also been devised. Using this type of girder, a complete model airship was constructed and subjected to various forms of loading, both local and general. Special attention was given to stability and to the effect of initial tension in the shear wires. The results obtained were used to check existing methods of stress calculation.

In the case of models of those structures for which exact theories exist, the test values agree with calculation to within 3 per cent. of the ultimate strength of the prototype member.

In connection with this research, a stress change recorder has been devised, which records both maximum stresses and the total number of stress changes of different magnitude experienced by an aircraft member during flight. The instrument consists of a number of ratchet wheels requiring a definite amount of motion (stress change) for operation. Suitable counting devices give the number of stress changes for each range. The weight of the recorder is stated to be a few ounces.

Empirical Formulæ for Allowable Compression Loads in Stiffened Sheet Panels. (E. R. Reff, J. Aeron. Sci., Vol. 6, No. 12 (Section 1), Oct., 1939, pp. 505-510.) (72/38 U.S.A.)

The author presents a general formula for the strength of any flat sheet-stiffener combination, the necessary empirical constants being given for a limited range of extruded stiffener shapes. It is suggested that this formula may be utilized in laying out test schedules for other stiffener shapes for which such constants are not now available. Existing test results, if sufficiently broad in scope, may be used to determine the empirical constants for stiffener shapes other than those considered. The number of tests necessary to obtain design data for a given range of stiffener shapes and sizes may be greatly reduced by use of the formula, and determining the necessary empirical constants, rather than running a complete schedule of exhaustive tests, will expedite stress analysis procedure. It is recommended that further tests be run to correlate the effects of rivet spacing.

Increase of the Specific Load Under Tension, Compression and Buckling of Welded Steel Tubes in Aeroplane Construction by Suitable Treatment of Structural Steel and by Proper Design. (J. Muller, L.F.F., Vol. 16, No. 1, 10/1/39, pp. 14-17. Available as Translation No. TM. 912.) (72/39 Germany.)

In the well-known Euler Formula for the buckling strength of a strut, the limiting load at a given slenderness ratio $L/_k$ (where $K^2 \times$ area = Moment of Inertia of Section) depends only on Young's Modulus of the material, and is thus practically independent of the heat treatment of the steel. Failure is assumed to take place under bending only and compression forces are neglected. This is legitimate for very long struts. Shorter struts however may fail under compression and the limiting load is thus very much lower than that given by Euler. By using heat treated Cr. Mb. steels, the Euler curve will be approached at smaller value of the slenderness ratio, and the buckling load for short struts raised appreciably above that obtainable with ordinary steels, provided failure at the weld is avoided, i.e., weld made as strong as the rest of the tubes. The simplest manner of achieving this is to thicken the tube ends and a method of construction embodying this feature has been patented by the Focke-Wulf Aircraft Company (Germany). The undercarriage of the F.W.200 (Condor) aircraft incorporates this feature.

If the component is under tension, the saving in weight for long struts can be made to approach the ratio of annealed to heat treated strength of the material, i.e., approximately 50 per cent.

The following table gives test results on a series of steel tubes tested for buckling with no end fixity.

Material.	Ultimate Strength kg./mm.²	Buckling Strength kg./mm.² at Slenderness Ratio. 20	40	60	80	100
Carbon Steel	60	40	35	30	25	20*
Cr. Mb. Steel (no heat treatment) ...	70	60	50	40	30*	20*
Cr. Mb. Steel (heat treated)	115	—	70	55*	30*	20*
Cr. Mb. Steel, with ends reinforced and welded as per F.W. Patent ...	115	95	90	55*	30*	20*

* This indicates that the Euler value is reached at this slenderness ratio. All the other values are below the Euler limit.

Bearings. (C. F. Smart, Metal Progress, Vol. 36, No. 4, October, 1939, pp. 349-50.) (72/40 U.S.A.)

Recent progress in bearings has been more along structural lines than through the development of new or improved alloys. Silver, and silver-lead, and aluminium have been given some attention, but these are apparently still much in the experimental stage. In general, four types of materials are in extended use for bearing metals—lead base babbitts, tin base babbitts, cadmium alloys, and copper-lead alloys. Each of these appears to have a field of usefulness determined by working conditions and design requirements.

Powder metallurgy is proving useful in some phases of bearing manufacture; one bearing soon to be available will be a new type copper-lead bearing, made by powder metallurgy processes, from chemically pure constituents, and uniformly distributed throughout the alloy. In another type of bearing a powder metallurgy composition is sintered on a steel back to serve as a mechanical reinforcement to a relatively thin layer of babbitt metal. Babbitt layers 0.003 in. thick applied over steel backs with an intermediate layer of bronze (the so-called tri-metal bearings) have recently been introduced and some tests indicate that these have appreciably higher fatigue life than bearings with greater babbitt thickness.

Electro-deposition of thin bearing metal layers as a method of producing bearings is in an experimental stage of development.

Glass Fibre Electrical Insulation. (R. Quarendon, Electrical Engineer, 27/10/39, p. 1020. Met. Vickers Tech. News Bull., No. 682, 27/10/39, p. 4.) (72/41 Great Britain.)

Fine glass fibres are produced in two forms. One is a short staple glass "wool" which is gathered into a sliver and spun into a yarn like wool or cotton. The other is a glass silk which is produced as very fine filaments. These two forms are suitable for electrical insulation. Several advantages are claimed for such insulation, such as mechanical strength at elevated temperatures and resistance to cutting under pressure; insulation resistance and dielectric breakdown strength are also claimed to be superior to those of ordinary insulating materials. Fields of application include traction motors, road and rail, where weight is an important factor, and in chemical process work, where corrosive liquids and vapours are encountered.

Illustrated with one photograph.

Creep of Metals. (H. W. Gillett, Metal Treatment, Autumn, 1939, pp. 115-121. Met.-Vickers Tech. News Bull. No. 683, 3/11/39, p. 1.) (72/42 Great Britain.)

The author directs special attention to the scarcity of creep experimental data and critically considers various attempts that have been made to obtain information about creep behaviour by means of tests of relatively short duration. He also deals with the theories that have been devised to explain the differences in low and high temperature behaviour of metals and gives a review of what is at present known as regards grain size and composition of structure.

Illustrated with one graph.

Rubber Suspension. (A. S. Krotz, J.S.A.E., Vol. 45, No. 5, Nov., 1939, pp. 471-477, Transactions.) (72/43 U.S.A.)

The rubber torsion spring consists of an inner shaft surrounded by an annular layer of rubber bonded to the inner shaft and also to an outer metal shell. The outer shell is split into two segments. The spring is stressed in torsion by anchoring either the shaft or outside shell to the chassis and rotating the other member.

Engineering data and diagrams are presented to assist in the design and application of the rubber torsion springs in various ways to various types of automobile chassis as well as to railroad and streetcar suspensions. Included are methods of calculating angular deformation and considerable data on creep, hysteresis, durometer hardness and stress-strain relationships.

Mechanical and Electrical Methods for the Measurement of Rapidly Changing Phenomena. (J. Geiger, Glasers Ann., Vol. 63, 1/5/39, pp. 107-115. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 97.) (72/44 Germany.)

The author considers critically methods of measuring frequency, especially between 1 and 200 cycles, of importance in present-day development of the high-speed internal-combustion engine. An electrical method has the advantages of indication at a distance, simultaneous registration of a number of associated magnitudes on the same scale, and ability to magnify a selected portion; but scale relations are frequently non-linear, whilst the oscillograph conductor may pick up induced currents unless shielded, and optical errors may occur.

In addition, even a high-speed oscillograph has inertia.

Electrical methods include the resistance/pressure relation (subject to parasites); the piezo-electric effect in quartz (requiring good insulation and short conductors and difficult in matching); the photo-electric cell (requiring high amplification but insensitive to external effects); alteration of air-condenser capacity; armature generating a varying induced current; and the magneto-electric effect (giving

linear relations and insensitive to moisture and temperature). The last two methods are not suitable for high-frequency variations.

In the case of mechanical devices, the natural frequency of the system (either as a whole or of some parts such as the scriber) sets a limit to the accuracy of the reproduction. In mechanical linkages play is of great importance and the author describes how play can be ascertained by means of a neon light circuit. A small amount of play can usually be eliminated by means of a sufficiently powerful control spring. Curves are given showing the effect of various degrees of damping.

Fine Measuring Appliances. (K. Burger, Maschinenbau, Vol. 18, May, 1939, pp. 227-30. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 98.) (72/45 Germany.)

The author describes advances revealed at the Leipzig Fair of 1939 in fine-gauging appliances. These include automatic sorting-machines for bearing rollers, in which 3,000 rollers per hour are sorted in seven groups varying by 2μ in diameter. He states that electrical methods of measurement were increasingly in evidence, not only in the automatic-sorting types but also in high-precision devices wherein electromagnetic effects are used to avoid mechanical contact and to magnify variations. Dial gauges of new form and minute proportions represent examples of the tendency to extend inspection methods towards visible and away from tactile forms. Similarly a gear-tooth form tester is illustrated, in which errors are recorded on a paper strip; 1mm. deviation of the pen denotes 20 sec. of error, or 5μ at the pitch-circle of a 4 in. wheel. This machine is driven by a small electric motor, the speed of which can be regulated, so that the human element and the touch cultivated in the use of some gear-testers are eliminated. Other innovations indicate a similar drive towards visibility and record; a machine with a capacity of variation of $\pm 35\mu$ records on a strip with a scale of 1 mm. per 1μ variation. Some of the new instruments include pneumatic cushioning to soften the impact of parts under examination, and thus to reduce the wear and tear of the instrument.

Friction Wheels for Instrument Work. (A. Kuhlenkamp, Z.V.D.I., Vol. 83, 3/9/39, pp. 077-83. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 98.) (72/46 Germany.)

The author discusses the foundations of the theory of predictors for anti-aircraft gunnery and demonstrates the suitability of friction gearing for transmitting, multiplying, and correcting various motions connected with aircraft as targets. He observes that many difficulties were encountered at first owing to slip and creep at the contact-surface and that when high-friction materials were used to prevent this, serious wear and attrition occurred. The best materials for accurate friction gearing proved to be steel on steel; and in order to utilise their rather low friction coefficients, high normal pressures are adopted with high-geared reduction of the motion. By using high-speed friction-wheels the forces and slips can be kept low, whilst sufficient accuracy of measurement is attained. The author describes typical trains of gearing coupled by friction-wheels, in which velocity products are derived as required by the ballistic problems, including the usual flat disk on which a small roller is moved radially across the face, and also a more recent arrangement in which the flat disk is replaced by a spherical surface which can be rocked about its centre. He discusses the possibility of using such mechanisms in the computation of accelerations and of higher derivatives of velocity; but he admits that the accuracy of workmanship required becomes prohibitive.

Librascope Power Computor. (Aero Digest, Vol. 35, No. 4, Oct., 1939, p. 149.) (72/47 U.S.A.)

The computor consists of a small case on which are mounted 5 dials, calibrated respectively to read r.p.m., manifold pressure, fuel air ratio, altitude and intake

temperature. On setting the requisite values on these dials, 3 additional pointers give automatically the b.h.p., fuel consumption (gallons/h.) and b.m.e.p.

One setting of the instrument thus gives results which normally could only be obtained by three or more steps when using the engine performance chart. The instrument is specially useful for obtaining quickly the optimum operating conditions either for maximum power or best economy with change in altitude or intake temperature. It appears that the fuel consumption for constant h.p. can be reduced by decreasing the r.p.m. and increasing the boost. The ultimate limit to this adjustment is set by detonation in the engine and a maximum m.e.p. must therefore not be exceeded.

In cases where the engine is provided with an automatic mixture control, it is possible to dispense with one of the control dials, the calculation being carried out on the basis of r.p.m., boost, altitude and intake temperature only.

New Developments in the Riveting and Welding of Light Metals. (E. von Rajakovics, Z. Metallk., Vol. 31, May, 1939, pp. 137-40. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 112.) (72/48 Germany.)

The author observes that the ordinary aluminium-copper-magnesium alloy (duralumin type) cannot be used for riveting in the hard state, and that, owing to age-hardening, heat-treatment is complicated. He describes a new alloy of this type—duralumin 681 H—which can be used in the hard state, and has the further advantage that the shear strength of the rivets is increased by striking, whilst it is especially suitable for split rivets. Owing to corrosion, rivets of the aluminium-magnesium type cannot be used for joining duralumin or duroplat. In a new method of joining aluminium, introduced by A. and H. Weibel, the edges of the sheets to be welded are turned back through about 100 deg., and these flanges are welded with two carbon electrodes, bevelled at their inner faces and at an angle of about 20 deg. to each other. The flanges are heated to redness by the short-circuiting of a low-tension alternating current, the weld heat being thus virtually independent of the resistance of the welded material. Not only is less flux required for this method than for autogenous or resistance welding, but also a less sensitive flux may be used. The method is suitable for welding all light-metal sheets of 0.2-1.5 mm. (0.008-0.06 in.) thickness.

New Processes for Welding and Soldering Zinc, Aluminium and Magnesium. (K. Heinemann, Z. Metallk., Vol. 31, May, 1939, pp. 141-53. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 112.) (72/49 Germany.)

In order to avoid the use of lead-tin alloy ordinarily required for soldering pure zinc, a welding process has been developed. For galvanized sheet a zinc flux and zinc wire are used, the temperature of about 420°C. (790°F.) being obtained with a flame. Most zinc alloys cannot be satisfactorily welded, especially if they contain aluminium. For these alloys a kind of puddling weld can be made by using a templet, melting wire over the joint, and puddling the oxide out of the weld. Aluminium and its alloys can be welded, using covered electrodes, with a current of 140-280 amp. at 25-30 volts. This method is especially suitable for 5-10 mm. (0.2-0.4 in.) sheet; for thinner sheets, the Weibel method (Abstract 72/48) is recommended. In joining aluminium cables, the ends are passed into a graphited steel mould and a stearin flux is added; the whole is heated to 850°-900°C. (1,560°-1,650°F.) and aluminium is poured in, the insulation being protected by screening and cooling. Another method involves the reaction of heavy-metal chlorides with a soft aluminium solder, but there is a danger that the oxide skin may not be completely dissolved. Commercial magnesium alloys are, in general, easily weldable; those containing aluminium can have only short welds, owing to their liability to weld cracks. Magnesium is also now used in conductors of interior switches; for welding these, the ordinary flux and pure magnesium wire are used

with a supporting templet. In repairing welding of magnesium castings, the weld requires protection owing to the impossibility of removing the last traces of flux, which may lead to corrosion at the weld-seam.

Rationalisation by Production Control and Inspection. (W. Knichahn, Maschinenbau, Vol. 18, May, 1939, pp. 219-223. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, pp. 93-4.) (72/50 Germany.)

The author emphasizes the importance of system and measurement in the maintenance of general industrial efficiency. Citing as an example a commercial adding-machine, in which more than 70,000 manufacturing operations are required, he describes typical methods of improving or eliminating inspection. He illustrates a very accurate trigger, in which originally thirty-nine tolerances required inspection, which was redesigned so that only seventeen tolerances are needed. The relative cost of manufacture and inspection is illustrated by the gear-box-casing of a milling-machine and by a side-frame of the adding machine. In the former, making requires 335 minutes, and inspection 25 minutes, whilst in the latter, making needs 5 sec. and inspection 20 sec. The percentages are therefore 7.5 and 400 respectively. In order to render inspection cheaper and more reliable, limit gauges are replaced by indicator methods; and when the numbers are sufficient the parts are automatically inspected and sorted for selective assembly. The author advocates the use of methods for quickly revealing faulty work; e.g., when a bush is pressed into a lever the assembly-pressure is used as a check on the fit of bush and hole. He demonstrates, by data from practice, the possibilities in instrument work of new ideas. The typical adding-machine labour is distributed as to one-quarter in making the parts and three-quarters in assembly, so that the savings realizable in assembly by making details perfect are more than sufficient to cover the extra manufacturing cost of those details. The author demonstrates how by proper planning and control the cost of such work decreases progressively from year to year.

Tightening of Bolts. (H. Dentler, Maschinenbau, Vol. 18, April, 1939, pp. 185-7. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, pp. 94-5.) (72/51 Germany.)

The author describes an investigation into the security and uniformity of assembly of airscrews on aero-engine flanges. Five fitters with varied training and experience were selected, three types of nut and bolt were provided, and a number of spanners fitted with a lengthening-piece to afford extra leverage were rendered freely available. The men were instructed to pull up the nuts by their sense of feel and touch; the threads and nut-faces were oiled and greased. By a simple arrangement of a dial-gauge on the bolt-end, the extension and pull in the bolt were measured. The results are tabulated. The variation from the mean tension in the bolts attained 45 per cent. in one bolt. The author concludes that bolts and nuts involving risk to life cannot be safely left to the touch of the erector, and he recommends control by measurement of bolt-length.

ABSTRACTOR'S NOTE.—In an addendum Schönung describes three forms of safety spanners. These measure or indicate the torque exerted by the erector, whilst in one, operated hydraulically, the spanner slips as soon as a prearranged torque has been exerted.

Interchangeability in Modern Aircraft Production. (C. Heriel, J.S.A.E., Vol. 45, No. 5, Nov., 1939, p. 15 (Digest).) (72/52 U.S.A.)

With respect to aircraft mechanisms produced by conventional machine production methods, interchangeability is assured by tooling methods common to all

industries. The author deals with the more complex parts of the structure, such as wing and fuselage, and the development of faired surfaces involving double curvatures. Such curves and outlines are laid out full scale in a lofting department but it is not practical for shop men to scale dimensions direct from such lofted outlines, as no two men would scale to the same identical dimension. Therefore tables of offsets and bevels are prepared by the lofting department to convert significant points on the moulded surface into numerical values useful to engineering and tooling personnel. With a structure as large as the wing, a system of applied analytical geometry is used to calculate any point on the wing structure, which is treated as a geometric solid.

The Final Assembly of Aircraft. (H. F. Schwedes, J.S.A.E., Vol. 45, No. 5, November, 1939, pp. 15-16 (Digest).) (72/53 U.S.A.)

An efficient line assembly calls for design on production lines. The various component assemblies are manufactured complete in jigs in various departments, and are brought in to final assembly completely finished and painted, no fitting or other hand work being required.

It is essential, of course, that the sub-assemblies manufactured under this system are all ready for final assembly at the required time, and this necessitates efficient production control. Experience for this is gained by starting with a preliminary lot of say 5 planes to complete tooling and checking of jigs. The final assembly is accompanied by moving the plane progressively through a set of stations (usually 8) with a special crew at each station trained for the particular work required.

It is claimed that by adopting these methods, the North American Aviation Co. have established a peacetime production record over the first six months of 1939 by turning out 103 aircraft in one month of 23 working days.

Accelerated Aircraft Production for National Defence. (P. N. Jansen, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 16 (Digest).) (72/54 U.S.A.)

Prototypes must be turned out very much faster than in the past, and this means that many details of the structure will be more expensive, and fittings which eventually will be forgings have now to be hogged out of solid stock. This, however, does not mean that liaison between shop and design departments may be relaxed. In addition to being mainly " performance minded," the latter department must be " production minded " as well. As regards tooling, it is interesting to note that the author considers that any reduction in production costs is small once quantities in excess of 100 are handled. The major part of the costs is connected with installation of parts, accessories and sub-assemblies.

Extreme simplification of the major structural components (such as by the adoption of plastics) does not necessarily produce a reduction in production costs since the installation of accessories and sub-assemblies is bound to become more difficult.

New Method of Developing Prototype Aeroplanes as Applied to Consolidated Model 31. (B. W. Sheahan, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 16 (Digest).) (72/55 U.S.A.)

Outside interference and too close co-operation with the customer is the main reason for time lost in the developing of experimental aircraft. Another source of delay is the time taken up with accessories and installations which are not part of the aircraft proper, but which will ultimately be required if the aircraft is to fulfil specialised duties. It is much better to concentrate on the construction of the aircraft, a study of a mock-up insuring at an early stage that these accessories can be eventually incorporated. By concentrating on essentials, the large con-

solidated Flying Boat Model 31 was turned out in under ten months, approximately 1,000 drawings being required in all.

Design Problems in the Quantity Production of Engines. (H. C. Hill, J.S.A.E., Vol. 45, No. 5, November, 1939, pp. 16 and 21 (Digest).) (72/56 U.S.A.)

The major difficulty in the quantity production of engines is the relatively large number of changes required (averaging in some case 10 changes per 18 engines built).

Such changes range from finning to connecting-rod design and are not excessive, considering the extreme complexity of the modern power plant, such as a two bank radial. Accumulated service experience calls for design changes and it is the duty of the production department to see that such changes, whilst improving the article, do not detract from the ease of manufacture. A case in point is the forged steel crankcase, machined all over, which now forms a characteristic feature of large power American engines. Such crankcases are as light as the previous alloy cases, but much more reliable. At the same time their cost is the same. A frequent source of hold-up in production is the multiplicity of inspections insisted on by customers. Careful specifications of requirements as to desired finishes and tolerances together with the application of such instruments as the profilometer will avoid much of inspection controversy.

Engine units must become more compact and more accessible. Provision must be made for an increasing number of accessories, each of which should be readily accessible and removable.

Drying with Near Infra-Red Radiation. (L. S. Ickis, Jnr., and H. H. Haynes, Gen. Elect. Rev., Vol. 42, April, 1939, pp. 145-9. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 95.) (72/57 Great Britain.)

Heating elements such as the steam radiator, which does not glow, emit infra-red energy of long wave-lengths (far infra-red). The filament lamp, like the sun, is a source of near infra-red energy. This is the portion of the spectrum which lies chiefly in the wave-lengths slightly longer than the red visible radiation. The 250-watt drying-lamp is designed to be most effective for vapourizing the most common solvents and washes. Typical lacquers have their greatest absorption in the visible and near-visible region of the spectrum. The drying-lamps, which are fitted with reflectors, operate at a colour temperature of 2,500 K., in comparison with the 3,000 K. of filament lamps for illumination. Tunnels lined with lamps and reflectors are in use in a motor-car factory. The authors state that the prime coat on a car can be dried in 7 min. and the finishing coats in 14 min.

The Periodic Flow of Heat in a Hollow Cylinder. (J. H. Awberry, Phil. Mag., Vol. 28, No. 189, Oct., 1939, pp. 447-54.) (72/58 Great Britain.)

The problem of the flow of heat in a hollow cylinder, when the temperature of the inner wall is constrained to vary periodically, and the heat loss from the outer surface is proportional to its temperature excess over the surroundings, is investigated mathematically. The theory has applications to the heat phenomena in the cylinder of an engine, and would also be needed in determining the thermal diffusivity of a metal experimentally by measurements of temperature waves in a hollow rod.

The various Bessel functions occurring in the solution are complex numbers, though the expressions for such physical quantities as the amplitude and phase lag are real. The formulæ are written (in terms of the real and imaginary parts of the Bessel functions) so as to exhibit these quantities in a purely real form. The functions themselves are given in the tables of Jahnke and Emde in a form suitable for computation.

A New Apparatus for Direct Reading of Pitch and Intensity of Sound and its Application. (J. Obata, R. Kobayashi, Electrotechnical Journal, July, 1939, pp. 152-6. Metropolitan-Vickers Tech. News Bull., No. 681, 20/10/39, p. 8.) (72/59 Great Britain.)

In acoustical investigations, it frequently happens that a graphical representation of the pitch of the sound, regardless of its wave form, is required. The authors describe the principle underlying an apparatus designed for this purpose. This apparatus is claimed to be an improvement upon previous arrangements and an additional device for recording variations in intensity has been incorporated. Examples of its application are given.

Illustrated with two photographs, one diagram, five oscillograms and two graphs.

A Sound Pitch Indicator, Incorporating the Thyratron. (T. A. Sterne and H. J. Zimmerman, J. Sci. I., Oct., 1939, pp. 334-6. Met.-Vickers Tech. News Bull., No. 682, 27/10/39, p. 7.) (72/60 Great Britain.)

In an instrument designed for making pitch variations visible, sound impulses are fed to an electronic frequency meter, the output of which is directly proportional to the fundamental frequency. The amplified voltage is applied to the grids of seven thyratrons, which are biased by successively greater amounts. The number of thyratrons which fire at a given signal therefore depends on the frequency of the signal. The firing of each thyratron lights a neon lamp in its plate circuit, and since these lamps are arranged in a vertical column, the effect obtained is a column of light which rises and falls with rising and falling pitch.

Illustrated with one diagram.

The Degenerative Sound Analyser. (H. H. Scott, J.A.S.A., Oct., 1939, pp. 225-232. Met.-Vickers Tech. News Bull., No. 683, 3/11/39, p. 3.) (72/61 Great Britain.)

Noises generated by machinery may be divided roughly into two classes, viz., sounds at the fundamental frequency at which the machine is operating, or harmonics of this frequency, and secondly components which are not definitely related in frequency to the fundamental speed of the machine. Various types of analysers are discussed and the disadvantages of the heterodyne analyser considered. The degenerative sound analyser is then shown to possess qualities which, it is claimed, make it suitable for industrial noise analysis. It consists essentially of a high gain amplifier and a feed-back network which is so designed that all frequencies, except that to which the analyser is tuned, are fed back to the input of the amplifier, with such a phase relationship as to produce degeneration and consequently cancellation of the gain. The maximum gain of the amplifier is obtained, therefore at the frequency to which the device is tuned and drops off rapidly on either side of this frequency. The use of the analyser is described in some detail, with examples.

Illustrated with one photograph, one diagram and four graphs.

Communication With and on Railway Trains. (A. G. Shaver, J. Western Soc. Engrs., Vol. 44, April, 1939, pp. 58-69. Eng. Absts., Vol. 2, No. 7, Section 2, pp. 91-2.) (72/62 Great Britain.)

The author describes the results of experiments made during the past ten years to develop a system of wireless communication for use on trains, between the driver and the guard, between parts of trains that have been separated, or between trains and wayside controlling-points, such as dispatchers' offices and signal-boxes. On the long freight trains run in America such communication is desirable, since whistle and hand signals have only a limited field of usefulness. The track-rails are used to convey the speech effect, reinforced in some localities by a line wire run alongside and connected in parallel, the power for transmitting being obtained

from the headlight generator or from batteries, whilst the frequency-bands used preclude interference from or with outside sources. The author describes the equipment, and reviews its possible applications.

A General Radiation Formula. (S. A. Schelkunoff, Proc. Inst. Rad. Eng., Vol. 27, No. 10, Oct., 1939, pp. 660-666.) (72/63 U.S.A.)

In this paper a general formula is derived for the power radiated in non-dissipative media by a given distribution of electric and magnetic currents. Magnetic currents are included not only for the sake of greater generality but also because in problems involving diffraction through apertures and radiation from electric horns, the radiation intensity can be made to depend upon fictitious electric—and magnetic—current sheets covering the apertures or horn openings.

Part I consists of an introductory discussion, summary of the formulæ, and examples illustrating the convenience of the general formulæ, Part II contains a mathematical derivation of the radiation formulæ.

LIST OF SELECTED TRANSLATIONS.

NOTE.—Applications for the loan of copies of translations mentioned below should be addressed to the Under-Secretary of State (R.T.P.), Air Ministry, Dept. Z.A., London, W.C.2, and will be loaned as far as availability of stocks permit. Suggestions concerning new translations will be considered in relation to general interest and facilities available.

Lists of selected translations have appeared in this publication since September, 1938.

AERODYNAMICS AND HYDRODYNAMICS.

TRANSLATION NUMBER AND AUTHOR.	TITLE AND JOURNAL.
962 Walchner, O. ...	*On the Effect of Compressibility on the Pressure Readings of a Prandtl Tube in Flows at Subsonic Velocity.* (Jahrbuch der deutschen Luftfahrtforschung, Vol. 1, 1938, pp. 578-82.)
963 Ferrari, C.	*On the Theory of Turbulence.* (Torino Reprint, No. 115, May, 1938.)

AIRCRAFT AND ACCESSORIES.

938 Leisz, K.	*Effect of the Individual Structural Quantities on the Flutter and Aperiodic Tilting of Lifting Surfaces, with and without Ailerons. (Without taking into account internal damping.)* (Jahrbuch der deutschen Luftfahrtforschung, 1938, Vol. 1, pp. 259-73.)
952 Gebhardt, W. ... Scheiferdecker, A. ...	*Results of Flight Measurements made with the "Raethjen" Theodolite Instrument by the Deutsche Forschungsanstalt fur Segeflug e.v.* (Jahrbuch der deutschen Luftfahrtforschung, 1938, Vol. 1, pp. 611-26.)
971 Bader, W.	*Measurements on a Low-Wing Monoplane in a Rotating Jet and Comparison with Flight Experiments.* (Luftfahrtforschung, Vol. 16, No. 2, 20/2/39, pp. 104-111.)
974 Kaufmann, W. ...	*On the Conditions of Similitude for Model Tests on Wing Flutter.* (L.F.F., Vol. 16, No. 1, 10/1/39, pp. 21-5.)

MATERIALS AND ELASTICITY.

946 Rotscher, F.	*Accurate Elongation Measurements.* (V.D.I. Lectures, Berlin, 1936 (Prufen Und Messen), pp. 142-9.)
960 Buchman, W. ...	*Fatigue Strength Properties of Electron Alloys in Particular the Effect of Notches in Ductile Alloys.* (Jahrbuch der deutschen Luftfahrtforschung, Vol. 1, 1938, pp. 524-8.)

TRANSLATION NUMBER AND AUTHOR.		TITLE AND JOURNAL.
968	Siebel, G.	*Further Development of Aluminium-Magnesium Alloys.* (Jahrbuch der deutschen Luftfahrtforschung, Vol. 1, 1938, pp. 511-4.)
969	Fischer, G.	*The Notch Effect in Alternating Fatigue Stressing and the Effect of Cold Working on Strength.* (Jahrbuch der deutschen Luftfahrtforschung, Vol. 1, 1938, pp. 517-523.)
		ENGINES AND ACCESSORIES.
958	Pfleiderer, C.... ...	*Supercharger with Radial Blades on Backward Curved Blades.* (Jahrbuch der deutschen Luftfahrtforschung, 1938, Vol. 2, pp. 187-95.)
967	Betz, A.	*Axial Blowers.* (Jahrbuch der deutschen Luftfahrtforschung, 1938, Vol. 2, pp. 183-6.)
		THEORY OF WARFARE.
972	Deutsch, F. W. ...	*Armament and Equipment of Aircraft.* (Extract from Waffenlehre (Armament Textbook), Section 6, C.1-3, 1939, pp. 194-200.)
975	Herrara, E.	*Passive Defence Against Air Bombardment Based on Experience in the Spanish War.* (L'Aérophile, Vol. 47, No. 8, August, 1939, pp. 175-8.)

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AERO ENGINES

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Benzinmotoren für Flugmodelle und ihr Selbstbau. Von A. Felgiebel. Verlag Volckmann, Berlin.

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1. Méthode Puits-Tourbillonnaire d'Hypersustentation et de Diminution de la Trainée.

2. Ondes hypersoniques dans les Gaz.

3. Comparaison de la méthode des Variables ϕ, ψ_1, ψ_2, t, à celles des Variables d'Euler et de Lagrange.

4. Équations approchées des Mouvements trois-dimensionnels d'un Fluide parfaitement compressible.

(*See* also "Publications of the Université de Lille.")

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No. 1831. Simple Formulæ for the Fundamental Natural Frequencies of Cantilevers. P. B. Walker.

No. 1832. Critical Reynolds Numbers of Spheres in the Compressed Air Tunnel. A. Fage and D. H. Williams. 1/3.

No. 1833. Notes on Longitudinal Stability at Low Speeds. R. H. Francis and G. E. Pringle.

No. 1834. An Analysis of the Stresses in a Flat Plate with a Reinforced Circular Hole under Edge Forces. By C. Gurney.

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No. **1837**. A Comparison of Aileron Control on Tapered Wings with Straight Leading Edge and Straight Trailing Edge. H. B. Irving and A. S. Batson.

No. **1838**. The Calculation of the Profile Drag of Aerofoils. By H. B. Squire and A. D. Young. H.M.S.O. 4/-.

No. **1839**. A Simplified Theory of Wing Flutter. A. G. Pugsley.

No. **1840**. The Lateral Stability of Highly-Loaded Aeroplanes. By L. W. Bryant and A. G. Pugsley. H.M.S.O., 1938. 2/-

No. **1841**. Hydraulic Operator for Remote Balance Control. By A. S. Halliday and C. H. Burge. H.M.S.O. 1/-.

No. **1843**. Experiments on the Transition of the Laminar Boundary Layer on a Flat Plate. By A. A. Hall and G. S. Hislop. H.M.S.O., 1938. 4/-.

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No. **1855**. Experiments on a Riveted Wing in the Compressed-Air Tunnel. By D. H. Williams and A. F. Brown. 9d.

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No. **1857**. A Possible Form of High-Speed Water Channel. By A. M. Binnie. H.M.S.O., 1938. 1/6.

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No. **1862**. Diffusion of Load in Sheet-Stringer Structures Having a Tapered Centre Stringer. By H. E. Smith. 1938. 2/-.

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No. **172**, January, 1939. Calculation of Induced Velocity by Helical Vortices and its Application to Propeller Theory. By Sandi Kawada.

No. **173**, February, 1939. On the Effect of the Density of the Air Upon the Pitot-Static Tube Coefficient. By T. Sasaki and K. Hattori.

No. **175**, May, 1939. Flight Tests on the Range of the Koken Long-Range Monoplane. By Hidemasa Kimura and Tatuo Takatuki.

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No. **179**, July, 1939. Measurement of Pressure Variations in the Neighbourhood of the Airscrew Blade. (Experiments with Actual Airscrew.) By Juichi Obata, Yahei Yosida and Umeziro Yosida.

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No. **181**, August, 1939. On the Frequency of Flexural Vibrations of a Rotating Propeller Blade. By Katsutada Sezawa and Ikuo Utida.

No. **182**, August, 1939. Note on the Effect of Boundary Walls of a Stream Upon the Circulation Round a Plane Aerofoil. By Susumu Tomotika, Ko Tamada and Y. Saito.

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No. 1. Il carroponte dinamometrico della vasca idrodinamica di Guidonia. C. Cremona. (The dynamometric mobile bridge in the Guidonia Towing-basin.)

No. 2. Sulla Misura ad Alta Precisione di Frequenze Radio. By E. Montuschi. (High-Precision Measurement of Radio Frequencies.)

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REVIEWS.

GREAT FLIGHTS.

E. Colston Shepherd. A. and G. Black, London. 7/6 net.

The present editor of "The Aeroplane" and formerly aeronautical correspondent of "The Times," has trodden well-worn ground, but he has an eye for description which sheds a new light on aeronautical history. His book deals with the great pioneering flights of Ross and Keith Smith, Alcock and Brown, the R.34, Marquis de Pinedo, Lindbergh, Bert Hinkler, Amy Johnson, Sir Hubert Wilkins, Kingsford Smith, Wiley Post, and Amelia Earhart, that remarkable flight which ended in the conquest of Mount Everest, and many others.

Mr. Shepherd not only writes with the studied ease of a practised writer, but he writes with a knowledge of flying which enables him to throw a searchlight on the real difficulties of the great air pioneers.

One thing above all others stands out in these vivid stories of the great pioneer flights, the thoroughness with which the pilots concerned made their preparations. No flight was successful due to mere luck. Everything that could be foreseen and prepared for was taken into account, and the old saying about genius being a capacity for taking pains was proved over and over again. If anyone earned success, let alone deserved it, it was the flying pioneer. Add to that an enthusiasm which only the air engenders, and a capacity for keeping on keeping on when nature itself was fighting twenty-four hours a day against success, it is not surprising that success came.

Tales of high enterprise are never stale, no matter how often they are told, and when they are told as Mr. Shepherd tells them, they are worth reading again and again.

RED PILOT.

By Vladimir Unishevsky. Hurst and Blackett. 7/6.

Two distinct persons have collaborated here: Unishevsky the pilot and Unishevsky the propagandist. The former is a likeable lad, whom we might meet in any flying club throughout Europe; his first solo is the first solo of us all, but tinged with a Slav wistfulness that sets it apart: "When I landed again the instructor shook me by the hand. He was an old man, to whom flying was now a profession, an everyday affair: but he looked me in the eyes and said nothing. And when I . . . began telling him how unspeakably glorious it was to fly alone, he smiled softly and wished me luck as an airman."

Furthermore, he has a schoolboy sense of humour, and a most un-Russian resourcefulness and driving force which (with the termination of his name) suggest that he descends from the more aggressive Polish race.

Unishevsky the propagandist is a less sympathetic character. On its lurid yellow jacket, his book is described as a "sensational and startling picture of Russia's industrial chaos . . . a convincing indictment of the Soviet régime." Sensational and startling, certainly. But convincing. Unfortunately he spoils his case by over-statement. If all Russian aerodromes were quagmires, all Russian mechanics saboteurs or bunglers, all Russian aircraft falling to pieces—as he

suggests—it would hardly have been possible for the Berlin-Leningrad commercial service " Deruluft " to attain, in two years from its foundation, a 99 per cent. regularity. Nor could even super-pilots have put into the sky—and kept there—the hundreds of aeroplanes which I personally have seen (in 1933—the period covered by Unishevsky's book) flying in perfect formation over Moscow in the May Day parade. Mess and muddle there must inevitably be in a suddenly mechanised country as vast as Russia; but, *pace* Mr. Unishevsky, the Soviet régime, with their stiffening of foreign engineers, are doing their best to cope with it.

The facts seem to be that Unishevsky's independent spirit made him so unpopular with his superiors that he very wisely " flew the frontier " in one of the falling-to-pieces aeroplanes which he is so fond of describing. Safe outside his country, he now publicly abuses it—never a very estimable trait. But, however controversial the matter of his book may be, however hysterical its manner (except when he is describing his piloting experiences, when he recovers his sense of humour), it certainly should be read. A word of congratulation to the translator, who has achieved the triple feat of making the story sound as if it had originally been written in English, faithfully rendering flying slang and technical terms, and yet preserving the Russian atmosphere.

THE ART OF SOARING FLIGHT.

> A translation of " Die Hohe Schule des Segelfluges," by Wolf Hirth, translated from the German by Naomi Heron-Maxwell. Printed in Germany by Stuttgarter Vereinsbuchdruckerei AG., Stuttgart. Obtainable from " The Sailplane and Glider," 13, Victoria Street, S.W.1. Price 5/-.

Wolf Hirth is probably the only glider pilot, who is still carrying out remarkable performances, and who was already active in the very early days of gliding. This enables him to give in his book a great deal of most useful advice and information. Apart from his own contributions, Wolf Hirth managed to get the collaboration of the best known German, English and American sailplane pilots. In a foreword by Miss Heron-Maxwell, which has a certain tragic touch at the present time, she says, " Soon after the original was published, it was translated into Polish, and it may be truly asserted that this was a considerable factor in placing Poland second only to Germany in the realm of motorless flight; at any rate, its immediate result was the acquisition of 19 Polish ' Silver C's ' within the year of its publication."

For the British pilots, who have comparatively little experience in storm-riding, there are some very useful remarks by Wolf Hirth, which should be of great value in spite of the " inferior quality " of our storms when compared with continental ones.

There is also a description of the first deliberately planned thunderstorm flight, which was carried out by R. Kronfeld, " Who," to use the words of Fritz Stamer, Director of the Wasserkuppe Gliding School, " inspired Hirth to carry out his record breaking flights in the early part of his career."

The chapter about thermal soaring is most complete and contains contributions by Ludwig Hofmann and Peter Riedel.

The section on cloud flying has contributions by Wolf Hirth, Hofmann, Mayer and Dr. A. E. Slater, the Editor of " The Sailplane and Glider," as well as by W. Späte, who is a pilot of the Luft Hansa. (The present altitude record of 23,200 feet was created by Herr Flugkapitän Drechsel, another German airline pilot who is at the same time a glider enthusiast.)

Many readers will get new information from the article by Heinz Huth and G. Brütting describing experiences in local thunderstorms, which, until quite recently, were not considered to be of any use for soaring flights.

The long wave is dealt with by A. E. Slater and Wolf Hirth, who discovered it when observing a cloud (called the Moazagotl) north of the Riesengebirge. A. E. Slater also gives a survey of soaring in Britain as well as in America. He also contributes two short biographies of Eric Collins, of Dunstable fame, and Warren Eaton, the late President of the Soaring Society of America. America is also represented by two descriptional flights by L. B. Barringer.

Each chapter in the book has been written by an expert. Philip Wills, the present British record holder, tells us interesting stories about his 104-mile flight and the flights which gained him the height and long-distance records. He also describes a soaring expedition to South Africa. J. S. Fox describes a thunderstorm flight.

There is a chapter called " A Glimpse into the Future," by Wolf Hirth, and it is interesting that he believes in the future of the powered sailplane. He predicts the soaring holidays of the future when he thinks that articles like " How I power-soared to Finland " and " Soaring to the Sources of the Nile " will be published.

The book certainly serves a very useful purpose by showing the non-glider how much technical and meteorological knowledge, flying skill (including blind flying) and experience is required to make a good soaring pilot and it also cannot fail to be most useful, interesting and often thrilling to even the expert glider pilot himself.

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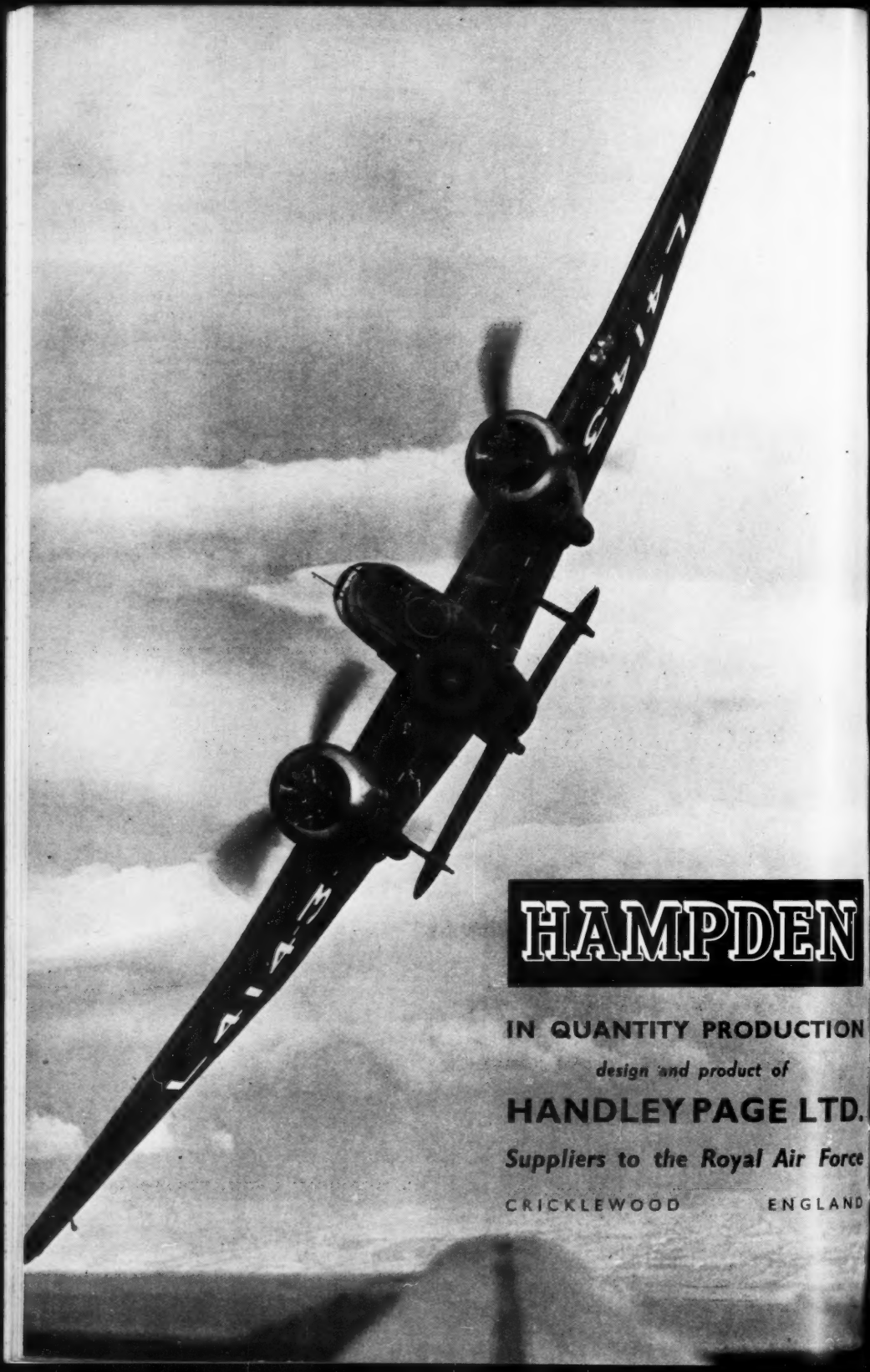
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INFORMATION BUREAU

One of the objects of the Society is the provision of technical information on all branches of aeronautics and its allied sciences. For that purpose a card index of information was begun in January, 1927, and now contains many thousand entries. The information given on these cards is at the disposal of all members of the Society free of charge.

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MONTHLY NOTICES

JANUARY, 1939

The New Year.

The President (Mr. A. H. R. Fedden), the Vice-Presidents (Mr. Griffith Brewer and Mr. D. R. Pye) and the Council wish all Members of the Society a Happy and Prosperous 1939.

New Year Honours, 1939.

Knight Bachelor.

W. Lindsay Everard, M.P. (Companion).

Air Force Cross.

Sqdn.-Ldr. J. F. X. McKenna (Associate Fellow).
Sqdn.-Ldr. G. Silyn-Roberts (Associate Fellow).
Flight-Lieut. C. A. Pike (Associate Fellow).

Journal.

The price of the JOURNAL is now 5/- per copy or 5s. 3d. post paid, and the annual subscription £3 3s. 0d. post paid.

Lecture Programme.

The following lectures have been arranged for the second half of the 1938-1939 Session. All lectures will be held in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, St. James' Park, S.W.1 (by permission of the Council of the Institution). Lectures commence at 6.30 p.m. and light refreshments will be served from 6 to 6.30 p.m.

Non-members will be admitted by ticket obtainable through a member of the Society.

Jan. 5th.—" The Use of Model Data in Aeroplane Design," Miss F. B. Bradfield, M.A., A.F.R.Ae.S., and Mr. D. L. Ellis, B.Sc., A.R.T.C., A.F.R.Ae.S.

Jan. 19th.—" Some Corrosion Problems Relating to Modern Aircraft," Mr. A. J. Sidery, A.F.R.Ae.S., and Mr. J. W. W. Willstrop, B.Sc., A.I.C.

Feb. 7th.—" Sleeve-Valve Engines," Mr. A. H. R. Fedden, M.B.E., D.Sc., M.I.A.E., M.S.A.E., F.R.Ae.S., Joint Lecture with the Institution of Automobile Engineers.

Feb. 16th.—" Ignition Problems," Dr. G. E. Bairsto, M.I.E.E., F.Inst.P.

March 2nd.—" Testing Stability and Control of Aeroplanes," Dr. A. G. von Baumhauer.

March 16th.—" Review of the Relative Merits of Carburettors and Direct Petrol Injection for Aero Engines," Mr. J. E. Ellor, F.R.Ae.S., and Mr. F. M. Owner, F.R.Ae.S.

March 30th.—" The Problem of Ancillary Power Services on Aircraft," Mr. F. Nixon, B.Sc., A.F.R.Ae.S., and Mr. R. H. Chaplin, B.Sc., A.F.R.Ae.S.

April 20th.—" Possible Steel Developments for Aircraft," Dr. T. Swinden, F.R.Ae.S.

May 4th.—" Strength of Thin Metal Construction," Mr. H. L. Cox.

May 25th.—Wilbur Wright Memorial Lecture, Dr. G. W. Lewis.

List of Members.

With the January issue of the JOURNAL is circulated the List of Members for 1939. The Secretary would be glad if members would notify any change of addresses from those given in the list.

Members' Subscriptions.

Members are reminded that their subscriptions were due on January 1st, 1939. The Council hope that every member will make every effort to pay his subscription as early as possible. The rates are:—

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Attention is drawn to the rule that where subscriptions are not paid by April 1st the JOURNAL is no longer sent, and no guarantee can be given that back numbers can be sent to members paying after that date.

Meeting of Council.

A meeting of the Council was held in the Offices of the Society on Wednesday, December 7th, 1938.

The following members were present:—Mr. A. H. R. Fedden (President) in the chair; Mr. Griffith Brewer (Vice-President), Mr. S. Camm, Dr. H. Roxbee Cox, Mr. W. C. Devereux, Mr. A. Gouge, Mr. A. H. Hall, Major D. H. Kennedy (Honorary Treasurer), Dr. N. A. V. Piercy, Professor A. J. Sutton Pippard, Mr. D. R. Pye (Vice-President), Mr. H. E. Wimperis (Past-President), Mr. L. A. Wingfield (Solicitor).

Among the business transacted was the following:—Lectures for the Second Half of the Lecture 1938-1939 Session; Report of the Finance Committee; Report of the Grading Committee; Draft Report of Aeronautical Engineering Degree Committee; Memorandum on the Journal of the Society; Proposed Annual Dinner and Dance.

Election of Members.

The following members were elected at the Meeting of Council held on December 7th, 1938:—

Fellows.—Albert Gillis von Baumhauer, James Edwin Ellor.

Associate Fellows.—Harold Alan Hamersley, James Clement Hornby, Peter Herbert Rayner (from Graduate), Alan Edward Richards (from Student), Henry Ernest James Rochefort (from Graduate), Hamish Murray Will (from Student).

Associate Members.—John Gilbert Olsen, William Thomas Wakeham (from Student), Harry Thomas Wood-Smith.

Associates.—Reginald William Allott, William Edward Baptist, William Howard Bell, Thomas Edgar Davies.

Graduate.—Robert Knight Page (from Student).

Students.—Peter Robert Allison, Paul Lionel Joseph Edwardes, Francis Guilbridge, Ronald Hills, Myer Julian Isador Kemper, Ronald Herbert Ponsford Nott, Richard Stallebrass.

Companion.—Godfrey Penington Kingdon.

Major Baden-Powell Memorial Prize.

The Major Baden-Powell Memorial Prize has been awarded to Mr. R. T. Wall, who was considered the best Student by the Examiners at the December Examinations. The prize is awarded twice yearly and is valued three guineas.

Associate Fellowship and Associate Membership Examinations.

The following is a list of those who passed in the December examinations, and the subjects in which they passed:—

ASSOCIATE FELLOWSHIP.

P. R. Allison	Theory of Internal Combustion Engines Applied Mathematics. Design (Aero Engines).
F. N. B. Bennett ...	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
J. R. Batty	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
A. E. Draper	Strength of Aeronautical Materials and Structures.
F. A. Firth	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
R. H. D. Forbes	Strength of Aeronautical Materials and Structures. Applied Mathematics. Aerodynamics (First Place).
T. D. Griffin	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
D. Hill	Strength of Aeronautical Materials and Structures (First Place). Applied Mathematics. Design (Aircraft).
O. L. Hyde	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
H. M. Kendall	Design (Aero Engines).
P. G. G. Knight	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
N. A. Simpson	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
R. T. Wall	Theory of Internal Combustion Engines (First Place). Applied Mathematics (First Place). Design (Aero Engines) (First Place).
C. H. Wang	Theory of Internal Combustion Engines. Applied Mathematics. Aerodynamics.

ASSOCIATE MEMBERSHIP.

D. R. F. Barron	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
D. Diamond	Pure Mathematics. Design (Aircraft).
W. H. Edwards	Theory of Internal Combustion Engines (First Place). Applied Mathematics (First Place). Design (Aero Engines) (First Place).
R. S. Emerson	Design (Aero Engines).
S. G. Heath	Applied Mathematics.
H. B. H. Judd	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
H. M. D. Magill	Applied Mathematics. Design (Aero Engines).
F. C. Nottingham . .	Aircraft Materials.
B. H. Pegge	Applied Mathematics. Design (Aircraft).
R. F. Rowley	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).
R. Stallebrass	Theory of Internal Combustion Engines. Applied Mathematics. Design (Aero Engines).

Society of British Aircraft Constructors' Scholarships.

The Society of British Aircraft Constructors are offering a minimum of four scholarships a year of varying value up to a maximum of £100 each per annum. The scholarships are designed for the assistance of young men, between the ages of 16 and 18, who are unable, for financial reasons, to take up a course of education fitting them to become aircraft engineers.

Each scholarship will be for four years, contingent upon satisfactory work being done by the holder and will be tenable with certain selected firms in the industry. The award of the scholarships will be made by a joint committee of the Society of British Aircraft Constructors and the Royal Aeronautical Society. The Royal Aeronautical Society will be responsible for the general administrative and other arrangements. The Selection Committee will normally make awards in April each year, and for 1939 application for the necessary form and particulars should be sent to the Secretary of the Royal Aeronautical Society, 7, Albemarle Street, W.1, before February 28th, 1939.

Acknowledgments.

The Council acknowledge their grateful thanks for the gift of back Journals from Major B. W. Shilson, Fellow, and Professor G. I. Taylor; and 21 volumes of Abridgements of Patent Specifications, Internal Combustion Engines, complete from 1855 to 1920.

Additions to the Library.

Jane's All the World's Aircraft, 1938. Compiled and Edited by C. G. Grey. Sampson, Low. £2 2s. od.

The Air Almanac. Air Publication 1802. H.M. Nautical Almanac Office, H.M.S.O. 5/-.

Diesel Engines. B. J. Von Bongart. Chapman and Hall. 21/-.

Elementary Matrices and Some Applications to Dynamics and Differential Equations. R. A. Frazer, W. J. Duncan and A. R. Collar. Cambridge University Press. 30/-.

Dust Storms in Iraq. F. E. Coles, Meteorological Office. H.M.S.O. 4d.

Die Durchschlagskraft eines Schwach Gekrummten Balkens. K. Marguerre. (Pamphlet.) Berliner Mathematischen Gesellschaft.

Die Stabilitatsgrenze eines Gekrummten Plattenstreifens bei Beanspruchung durch Schub-und Langskräfte. A. Kromm. (Pamphlet.)

The Loading of Inter-Connected Bridge Girders. A. J. S. Pippard and J. P. Armand de Waele. (Pamphlet.) Institution of Civil Engineers.

The Reduction of Carrying Capacity of Pipes with Age. C. F. Colebrook and C. M. White. (Pamphlet.) Institution of Civil Engineers.

The Protection of Dams, Weirs and Sluices Against Scour. R. V. Burns and C. M. White. (Pamphlet.) Institution of Civil Engineers.

The Size-Grading of Sand by Wind. R. A. Bagnold. (Pamphlet.) Royal Society.

The Climate of the British Isles. E. G. Bilham. MacMillan and Co., Ltd.

Hughes' Tables for Sea and Air Navigation. Compiled by L. J. Comrie. Henry Hughes and Son, Limited.

The Book of the Sextant. A. J. Hughes. Brown, Son and Ferguson. 5/-.

A Simple Study of Flight. J. D. Haddon. Sir Isaac Pitman and Sons, Limited. 4/-.

Parachuting. Charles Dixon. Sampson, Low. 3/6.

Technical Reports of the National Advisory Committee for Aeronautics:—

No. 627. The Experimental and Calculated Characteristics of 22 Tapered Wings. Raymond F. Anderson.

No. 628. Aerodynamic Characteristics of a Large Number of Airfoils Tested in the Variable-Density Wind Tunnel. Robert M. Pinkerton and Harry Greenberg.

No. 631. Airfoil Characteristics as Applied to the Prediction of Air Forces and Their Distribution on Wings. Eastman N. Jacobs and R. V. Rhode.

No. 632. The Crinkling Strength and the Bending Strength of Round Aircraft Tubing. William R. Osgood.

No. 633. Pressure Distribution Over an N.A.C.A. 23,012 Airfoil with a Slotted and a Plain Flap. Carl J. Wenzinger and James B. Delano.

No. 634. Calculation of the Chordwise Load Distribution Over Airfoil Sections with Plain, Split, or Serially Hinged Trailing-Edge Flaps. H. Julian Allen.

No. 638. The Influence of Lateral Stability on Disturbed Motions of an Airplane with Special Reference to the Motions Produced by Gusts. Robert T. Jones.

Technical Notes of the National Advisory Committee for Aeronautics:—

No. 655. Principles Involved in the Cooling of a Finned and Baffled Cylinder. M. J. Brevoort.

No. 656. Hydrodynamic and Aerodynamic Tests of Models of Floats for Single-Float Seaplanes. N.A.C.A. Models 41-D, 41-E, 61-A, 73 and 73-A. J. B. Parkinson and R. O. House.

No. 657. Tank Tests to Show the Effect of Rivet Heads on the Water Performance of a Seaplane Float. J. B. Parkinson.

No. 658. Generalised Analysis of Experimental Observations in Problems of Elastic Stability. Eugene E. Lundquist.

No. 659. Wind-Tunnel Tests of Three Lateral-Control Devices in Combination with a Full-Span Slotted Flap on an N.A.C.A. 23,012 Airfoil. Carl J. Wenzinger and Millard J. Bamber.

No. 660. Fatigue Testing of Wing Beams by the Resonance Method. William M. Bleakney.

No. 661. Wind-Tunnel Investigation of Rectangular and Tapered N.A.C.A. 23,012 Wings with Plain Ailerons and Full-Span Split Flaps. Carl J. Wenzinger.

Reports and Memoranda of the Aeronautical Research Committee.

No. 1812. Variations of Shear Stress in Thin-Walled Tubes under Torque. D. Williams and J. Taylor.

No. 1831. Simple Formulæ for the Fundamental Natural Frequencies of Cantilevers. P. B. Walker.

No. 1833. Notes on Longitudinal Stability at Low Speeds. R. H. Francis and G. E. Pringle.

No. 1837. A Comparison of Aileron Control on Tapered Wings with Straight Leading Edge and Straight Trailing Edge. H. B. Irving and A. S. Batson.

No. 1839. A Simplified Theory of Wing Flutter. A. G. Pugsley.

Conquest of the Skies. Peter Merin. John Lane, The Bodley Head. 12/6.

Practical Aircraft Stress Analysis, Second Edition. D. R. Adams. Sir Isaac Pitman and Son, Ltd. 8/6.

Listen! The Wind. By Anne Morrow Lindbergh. Chatto and Windus. 7/6.

Icarus. An Anthology of the Poetry of Flight. Edited by R. de la Bere. Macmillan and Co., Ltd. 7/6.

Physical Science in Modern Life. By E. G. Richardson. English Universities Press, Limited. 8/6.

Joint Meeting—February 7th, 1939.

The attention of members is called specially to the Joint Meeting with the Institution of Automobile Engineers on Tuesday, February 7th, at 7.45 p.m., at the Royal Society of Arts, John Street, Adelphi, W.C.2, when Mr. A. H. R. Fedden, President of the Society, will read a paper on "Sleeve-Valve Engines."

Forthcoming Events.

Jan. 5th.—Lecture before the Society by Miss F. B. Bradfield, M.A., A.F.R.Ae.S., and Mr. D. L. Ellis, B.Sc., A.R.T.C., A.F.R.Ae.S., on "Use of Model Data in Aeroplane Design," at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1 (by permission of the Council of the Institution). Light refreshments will be served from 6 p.m. The chair will be taken by Mr. A. H. R. Fedden, M.B.E., M.I.A.E., M.S.A.E., F.R.Ae.S. (President of the Society).

Jan. 18th.—Meeting of Council at 5.30 p.m.

Jan. 19th.—Lecture before the Society by Mr. A. J. Sidery, A.F.R.Ae.S., and Mr. J. W. W. Willstrop, B.Sc., A.I.C., on "Some Corrosion Problems Relating to Modern Aircraft," at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers.

Feb. 7th.—Joint Lecture with the Institution of Automobile Engineers and other Institutions, by Mr. A. H. R. Fedden, D.Sc., M.B.E., M.I.A.E., M.S.A.E., F.R.Ae.S., on "Sleeve-Valve Engines." **This lecture will be held at the Royal Society of Arts, John Street, Adelphi, W.C.2, at 7.45 p.m.**

GRADUATES' AND STUDENTS' SECTION.

Jan. 10th.—Lecture on "Flying for Fun," by Mr. F. D. Bradbrooke, at 7 p.m. Illustrated with films. **This lecture will be held in the Assembly Hall, Central Hall, Westminster, S.W.1. No refreshments.** Mr. E. Colston Shepherd in the Chair.

Jan. 21st.—Visit to de Havilland Aircraft Company, Stag Lane, Edgware, Engines and Airscrew Departments, at 2.30 p.m. (Limited to 30 British subjects.) Names (British Subjects) must be in by January 7th.

Jan. 31st.—Lecture on "Influence of Airscrews on Engine Design," by Mr. F. M. Thomas, A.F.R.Ae.S., at 7 p.m. in the Library, at 7, Albemarle Street, W.1. Refreshments will be served from 6 p.m.

Feb. 14th.—Lecture on "Ignition," by Mr. F. R. F. Ramsay, at 7 p.m., in the Library, at 7, Albemarle Street, W.1. Refreshments will be served from 6 p.m.

BRANCHES.

Coventry Branch.

Wednesday, Jan. 4th.—Visit to Coventry Gauge and Tool Company, at 7.0 p.m.

Thursday, Jan. 19th.—Lecture by Mr. E. W. Knott on "Carburation as Applied to Modern Aircraft Engines," at 8.15 p.m.

Wednesday, Jan. 25th.—Visit to Messrs. Rolls-Royce, at Derby.

Isle of Wight.

Tuesday, Jan. 10th.—Lecture by H. Mason Garner, M.A., F.R.Ae.S., on "Research on Seaplanes."

Tuesday, Jan. 31st.—Lecture by R. Worsdale on "Manufacture of Light Alloys."

Tuesday, Feb. 14th.—Lecture by Sir A. Verdon-Roe, Kt., O.B.E., M.I.Ae.E., F.R.Ae.S., on "Past, Present and Future in Aviation."

Lectures are held at 6.30 p.m. in the Lecture Room at Columbine Works, Messrs. Saunders-Roe, Cowes.

Medway Branch.

Monday, Jan. 9th. Lecture by Mr. W. C. Devereux, F.R.Ae.S., on "Light Alloys."

Monday, Feb. 6th.—Lecture by Mr. G. Parkin, B.Sc., A.M.I.A.E., A.F.R.Ae.S., on "Constructional Features of the Merlin Engine."

Lectures are held at the Chatham Co-operative Hall, High Street, Chatham, at 7 p.m.

Portsmouth Branch.

Thursday, Jan. 12th.—Lecture by Mr. B. S. Shenstone, A.F.R.Ae.S., on "Recent Progress in German Aircraft."

Thursday, Jan. 26th.—Lecture by Mr. D. L. Ellis, B.Sc., A.R.T.C., A.F.R.Ae.S., on "The Wind Tunnel as an Aid to Aircraft Design."

Thursday, Feb. 9th.—Lecture by Captain A. S. Wilcockson on "Atlantic Crossings by Empire Boat."

Lectures are held in the Airspeed Social Club, Bowler Avenue, Copnor, Portsmouth, at 7.30 p.m.

Southampton Branch.

Wednesday, Feb. 1st.—Lecture by Mr. C. G. James on "The Metallurgy of Aircraft Materials."

Yeovil Branch.

Thursday, Jan. 12th.—Lecture by Mr. R. H. Bound, A.F.R.Ae.S., on "Retractable Undercarriages."

Thursday, Feb. 2nd.—Lecture by Mr. John Hopcraft, A.M.I.Ae.E., on "Steel Manufacture."

J. LAURENCE PRITCHARD, *Secretary & Editor.*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated The Institution of Aeronautical Engineers

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MONTHLY NOTICES

FEBRUARY, 1939

Annual General Meeting, March 29th, 1939.

The Annual General Meeting of the Society will be held at the **Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1** (by permission of the Council of the Institution), at 6.30 p.m., on Wednesday, March 29th, 1939. Notices will be sent to all members.

Nominations for Council.

Attention is drawn to Rules 68-85 regulating the constitution of the Council, and in particular to Rules 79 and 81, which read as follows:—

RULE 79.—One half of the Council (excluding the President and the Immediate Past-President if a Member of Council) shall retire annually. The members who shall retire shall be those longest in office, except as provided in Rule 85. Retiring members of Council who have served two terms in succession (four years) shall not be eligible for re-election until the next annual election, when they will be eligible.

RULE 81.—Nominations of candidates for election to the Council must be received by the Secretary not less than twenty-one days before the Annual General Meeting, with an intimation in writing by the candidates that they are willing to serve. Nominations must be signed by one supporter and two seconders, who must each be entitled to vote in the R.Ae.S.I.

Under Rule 105 the Annual General Meeting is held at some convenient date before the end of March of each year, so that nominations must be received during the first week in March, and preferably by March 1st at the latest.

Meeting of Council.

A Meeting of the Council was held in the Offices of the Society on January 18th, 1939.

Present: Mr. A. H. R. Fedden (President) in the chair; Professor L. Bairstow, Mr. R. Blackburn, Mr. S. Camm, Dr. H. Roxbee Cox, Mr. W. C. Devereux, Mr. A. Gouge, Major D. H. Kennedy (Honorary Treasurer), Mr. F. Handley Page, Dr. N. A. V. Piercy, Professor A. J. Sutton Pippard, Lord Sempill.

Among the business transacted was the following:—The Society's New Premises; Report of the Finance Committee; Report of the Grading Committee; Report of the House Committee; Agenda for the Annual General Meeting and Proposed Alterations to Rules; Wilbur Wright Memorial Lecture; Standardisation; Increased Membership of the Society; Representation of the Society at Meetings and Conferences; Presentation of the Guggenheim Medal; Appointment of Representative on the Engineering Joint Council.

Election of Members.

The following recommendations of the Grading Committee were approved by the Council at their meeting on January 18th, 1939:—

Fellows.—Herbert John Thomas, Horace Myers.

Associate Fellows.—William Henderson Coulthard (from Student), Thomas Leslie Garner, Frank Holmes Smith (from Student), Harry Owen Houchen, Louis Alexander George Howard (from Student), James William Kenny (from Student), Godfrey Henry Lee (from Student), Victor Hubert Leech, Edward William Lofts (from Student), Peter Reginald Poole (from Student), Warren Utley Snell, Eric Raymond Staniland, Ralph Francis Newman Swingler (from Student), Kenneth Jack Blackler Wolfe.

Associate Member.—John Henry Fulford.

Associates.—Miss Nancy Bird, Paul Howlett Campion, Cawas Burjorji Contractor, George Norman Snarey.

Graduates.—George Albert Campbell, William Isbister, Clifford Leslie Moon, Thomas Robert Nelson, William Anthony Porter, Robert Neville Sjogren.

Students.—Edward Geoffrey Barnes, Douglas Thornton Brown, Ernest Charles Brown, Eric Byron, Leslie Samuel Carthew, D. M. Cashmore, Thomas Charlesworth, Dennis Harvey Clarke, Ralph Henry Clifford, John Carol Collins, Eric Frank Cotton, George Cruickshank, James Henderson Deas, Harold B. Devereux, Kenneth Graham Furneaux, Thomas Kenneth Garrett, William Henry Noel Gibby, John Philip Golding, John Charles Oswald Grunert, Geoffrey James Bernard Hall, Charles John Hayne, Peter Davison Heuser, Denis Keogh Kempston, William Lauder McAllister, Herbert Ronald Marlow, Walter Herbert Mitchell, Henry Edward Monteith, Frederick William Pawsey, Albert George Reddy, Peter Richardson, Raymond Frederick Rowley, Roy Owen Roberts, Thomas Brabazon Rutherford, Percy Scott, Edward Sewell, Nelson Anthony Simpson, Bhupendra Singh, John Kelday Smith, Leon Edward Smith, James Alexander Stephen, John Frederick Story, John Blakemore Tayler, Roy Fenning Warren, Hugh Cecil Lovat White, Cyril Robert Wiggett, Ronald Winston Woolford.

27th Wilbur Wright Memorial Lecture.

The 27th Wilbur Wright Memorial Lecture will be given by Dr. G. W. Lewis, F.I.Ae.S., on Thursday, May 25th, 1939. The lecture will be held at the Institution of Mechanical Engineers (by permission of the Council of the Institution), Storey's Gate, St. James's Park, S.W.1. Further particulars will be announced later.

Binding of Journals.

Arrangements have been made for Members' Journals to be bound at the special price of 4s. 6d. per volume for the current volume and 5s. 6d. for back volumes. Journals should be sent direct to the Lewes Press, Limited, Friars Walk, Lewes, Sussex, and a remittance to the Society.

Leverhulme Research Fellowship, 1939.

Applications are invited for Fellowships and Grants in aid of research. The Fellowships or Grants are intended for senior workers who are prevented from carrying out research work by routine duties or pressure of other work. They are limited to British-born subjects normally resident in Great Britain. In exceptional circumstances the Trustees may waive the condition as to residence. Forms of application may be obtained from the Secretary, Dr. L. Haden Guest, Leverhulme Research Fellowships, Union House, St. Martin's-le-Grand, London, E.C.1. Applications must be received on or before March 1st, 1939. Awards will be announced in July and the Fellowships or Grants will date from September 1st, 1939.

Acknowledgments.

The Council acknowledge with grateful thanks the gift of two books for the Library from Mr. W. O. Manning, Fellow, and the gift of *Journals* from Miss C. B. Etty-Leal, and a copy of "Through the Overcast, The Art of Instrument Flying," by Assen Jordanoff, presented by Mr. J. V. Holman, Associate.

Joint Meeting with Other Institutions.

A Joint Meeting with the Institution of Automobile Engineers and other institutions will be held on Friday, March 10th, at 7 p.m., in the Great Hall of the Institution of Civil Engineers, Great George Street, S.W.1. The subject under discussion will be "Comfort in Travel."

Additions to Library.

Reports and Memoranda of the Aeronautical Research Committee:—

No. 1812. Variations of Shear Stress in Thin-Walled Tubes under Torque, by D. Williams.

No. 1831. Simple Formulæ for the Fundamental Natural Frequencies of Cantilevers, by P. B. Walker.

No. 1833. Notes on Longitudinal Stability at Low Speeds, by R. H. Francis and G. E. Pringle.

No. 1837. A Comparison of Aileron Control on Tapered Wings with Straight Leading Edge and Straight Trailing Edge, by H. B. Irving and A. S. Batson.

No. 1839. A Simplified Theory of Wing Flutter, by A. G. Pugsley.

No. 1836. Elevator Fuselage Flutter, by G. A. Naylor.

Publications Scientifiques et Techniques du Ministère de l'Air:—

No. 130. La Fusion Industrielle du Magnésium et ses Moulages en Sable. Par A. Caillon.

No. 131. Recherches sur un Procédé de Détermination de l'Onctuosité des Lubrifiants. Par F. Charron.

No. 132. Mémoire sur l'Énergie d'Activation des Hydro-Carbures et l'Indice d'Octane. Par M. Peschard.

No. 133. Étude sur la Mesure de la Souplesse des Vernis pour Métaux. Par R. Habrekorn.

No. 134. Contribution à l'Étude de l'Hélice dans le Domaine du Point Fixe et de son Interaction avec l'Aile Sustentatrice. Par Svetopolk Pivko.

No. 135. Contribution à l'Étude de la Turbulence en Soufflerie. Par Georges Dubois.

No. B.S.T. 82. Résultats de Mesures en Vol de Couples de Moteurs. Par J. Salez.

Meteorological Office Professional Notes:—

No. 84. Dust Storms in Iraq, by F. E. Coles.

Meteorological Office Geophysical Memoirs:—

No. 77. An Investigation of the Lapse Rate of Temperature in the Lowest Hundred Metres of the Atmosphere, by N. K. Johnson and G. S. P. Heywood.

Mitteilungen aus dem Institut für Aerodynamik (Eidgenössische Technische Hochschule Zürich):—

No. 6. Untersuchungen über Grenzschichtabsaugung. Von A. Gerber. Verlag A. G. Gebr. Leemann and Co., Zürich. Frs. 5.50.

No. 7. Anwendung gasdynamischer Methoden auf Wasserströmungen mit freier Oberfläche. Von E. Preiswerk. Verlag A. G. Gebr. Leemann and Co., Zürich. Frs. 8.80.

Air Ministry:—
A.M. Pamphlet 86 (Nov., 1938). Civil Airworthiness Committee: Report on the De-Icing of Aeroplane Wings, Tail Surfaces and Control Surfaces. H.M.S.O. 2d.

National Physical Laboratory:—
Abstracts of Papers Published in 1937. H.M.S.O. 1/-.

Luftfahrt-Lehrbücherei (published by R. Mathiesen, Berlin):—
No. 3. Die Praxis des Metallflugzeugbauers. (1) Werkstoffkunde. RM. 1.80. By Karl Liebig.
No. 5. Elektrische Flugzeugausrüstung. By B. Klinker.
No. 7. Der Flugmotor. (1) Bauteile und Baumuster. By Hans Katz.
No. 14. Luftverkehr. By R. Schnitzler. RM. 1.25.

Der Facharbeiter im Flugzeugbau. (Published by Carl Marhold, Halle):—
No. 12. Der Werkstoffprüfer und Kontrolleur im Flugzeubau. By Fritz Krause. RM. 2.50.

Praktische Theorie in der Flugtechnik. (Published by Max Gehlen, Berlin):—
No. 7. Wägungen, Schwerpunkt, Ladepläne. By H. Wenke. RM. 2.50.
No. 8. Flugleistungsermittlung. By H. Wenke. RM. 4.00.

Smithsonian Institution (Washington, U.S.A.) Publications:—
No. 3453. Discoveries from Solar Eclipse Expeditions. By S. A. Mitchell.
No. 3455. The Thunderstorm. By E. A. Evans and K. B. McEachron.

Abhandlungen aus dem Aerodynamische Institut an der Technischen Hochschule, Aachen. Heft 16:—
1. Experimentelle Untersuchungen an freifahrenden Düsenkühlern. Von W. Linke.
2. Druckverteilung an Flügeln bei Anströmung von rückwärts. Von A. Neumann.
3. Systematische Windkanalmessungen an einer Modell-Luftschraubenserie. Von B. Dirksen.

The Air and its Mysteries. By C. M. Botley. G. Bell and Sons. 8/6.

Aluminium Bronze. Published by the Copper Development Association.

Benzinmotoren für Flugmodelle und ihr Selbstbau. Von A. Felgiebel. Verlag Volckmann, Berlin.

Bon Voyage. (Glossary of Travel Phrases in 18 Languages.) Published by Shell-Mex. 3d.

The Conquest of the Skies. By Peter Merin. John Lane. 12/6.

De Havilland General Information Booklet No. 5. (Brochure.)

Ditto. (Text in French.)

Entwicklungsrichtungen im Bau von Kraftmaschinen für Verkehrsmittel und ortsfeste Anlagen. (Paper—Reprint from D.V.L. Review, Vol. 82, No. 34.) F. Münzinger.

Entwurf und Berechnung von Flugzeugen. Band III. Leitwerk. Von Gerhard Otto. Verlag Volckmann, Berlin.

Flug-Wetterkunde. Von V. Oesterle. Herm. Beyer Verlag, Leipzig.

Flugzeugbau und Luftfahrt (Band 28): Werkstoffkunde für den Flugzeug und Motorenbau. Von C. Böhne. Verlag Volckmann, Berlin.

Flugzeugleichtmetallbau. Von Dr. K. Krieger. Mathiesen, Berlin.

Inchley's Theory of Heat Engines. 4th Edition, revised and edited by Dr. H. Wright Baker. Longman's. 14/-.

The Internal Combustion Engine. By C. F. and E. S. Taylor. International Textbook Co. (Pennsylvania, U.S.A.).

Librascope as Applied to Aircraft, The. (Pamphlet.) The Librascope Development Company.

Metal Spraying. (2nd Edition.) By E. C. Rollason (Revising 1st Edition by Taylor and Budgen). Chas. Griffin and Co. 15/-.

National Institute of Industrial Psychology. Annual Report for 1938.

Physikfibel für die Flakartillerie. Von Ph. Lötzbeyer. Max Gehlen, Berlin.

Schweisstechnik im Flugzeugbau. Von K. Queitsch. Mathiesen, Berlin.

Seemannschaft in der Luftwaffe, Die. Von T. E. Sönnichsen. Mittler und Sohn, Berlin.

Tank Strapping. By P. Kerr. (Proof of Lecture given before Royal Society of Arts, January 10th, 1939.)

Testing of Metallic Materials. By Ernest Skerry. Bunhill Publications, Ltd. 3/6.

Through the Overcast. The Art of Instrument Flying. Assen Jordanoff.

Views on Air Defence. By Lieut.-Gen. N. N. Golovine. Gale and Polden. 5/-.

Water and Water-Cooled Injection in a Supercharged Jaguar Aircraft Engine. (Reprint from Canadian Journal of Research, A. 16, 149-176, 1938.) National Research Council of Canada.

A.P. 949. The 12-Cylinder Liberty Aero Engine, 400 h.p. (1924). H.M.S.O. 1/6.

Instruction Book for Napier 12-Cylinder Aero Engine, Series 5 Type (The "Lion"). Published by D. Napier and Son, Ltd. 10/6. 1924.

Knapp's Annual of the East, 1938. (Edited by R. W. Brock.)

National Advisory Committee for Aeronautics:—

Report No. 638. The Influence of Lateral Stability on Disturbed Motions of an Airplane, with Special Reference to the Motions Produced by Gusts. By Robert T. Jones.

Forthcoming Events.

Feb. 7th.—Joint Lecture with the Institution of Automobile Engineers, by Mr. A. H. R. Fedden, M.B.E., D.Sc., M.I.A.E., M.S.A.E., F.R.Ae.S., on "Sleeve Valve Engines." This lecture will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, at **7.45 p.m.** Light refreshments will be served from 7.15 p.m.

Feb. 16th.—Lecture before the Society by Dr. G. E. Bairsto, M.I.E.E., F.Inst.P., on "Ignition Problems," at 6.30 p.m., at the Institution of Mechanical Engineers. Light refreshments will be served from 6 p.m.

March 2nd.—Lecture before the Society by Ing. A. G. von Baumhauer, on "Testing Stability and Control of Aeroplanes," at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers. Light refreshments will be served from 6.0 p.m.

March 10th.—Joint Meeting with the Institution of Automobile Engineers and other Institutions on "Comfort in Travel," at 7.0 p.m., in the Great Hall of the Institution of Civil Engineers, Great George Street, S.W.1.

Section 1—By Road.
Section 2—By Rail.
Section 3—By Air.

Graduates' and Students' Section.

Feb. 14th.—Lecture on "Ignition," by Mr. F. R. F. Ramsay. Lieut.-Col. L. F. R. Fell, D.S.O., O.B.E., F.R.Ae.S., in the chair.

Feb. 21st.—Lecture on "Duct Design," by Mr. G. N. Patterson, Ph.D., A.F.R.Ae.S. Mr. W. G. A. Perring, R.N.C., A.F.R.Ae.S., in the chair.

March 7th.—Lecture on "Plastics," by Mr. M. Langley, A.M.Inst.N.A., M.I.Ae.E.

Students' lectures are held in the Society's Library, at 7, Albemarle Street, W.1, at 7.0 p.m. Refreshments will be served from 6.0 p.m.

BRANCHES.

Belfast Branch.

Tuesday, Feb. 7th.—Lecture by Mr. J. Lankester Parker, A.F.R.Ae.S., on "Testing Prototype Aircraft."

Tuesday, March 14th.—Mr. J. G. Hopcraft, M.C., A.M.I.Ae.E., Film on Steelmaking with commentary.

Lectures are held in the Central Hall of the College of Technology, Belfast, at 7.45 p.m.

Isle of Wight.

Tuesday, Feb. 14th.—Lecture by Sir A. Verdon-Roe, Kt., O.B.E., M.I.Ae.E., F.R.Ae.S., on "Past, Present and Future in Aviation."

Tuesday, Feb. 28th.—Lecture by Mr. J. Hopcraft, on "Manufacture of Steel Alloys."

Tuesday, March 14th.—Debate (subject to be announced later).

Lectures are held at 6.30 p.m. in the Lecture Room at Columbine Works, Messrs. Saunders-Roe, Cowes.

Medway Branch.

Monday, Feb. 6th.—Lecture by Mr. G. Parkin, B.Sc., A.M.I.A.E., A.F.R.Ae.S., on "Constructional Features of the Merlin Engine."

Monday, March 6th.—Lecture by Captain A. S. Wilcockson, on "Atlantic Air Routes."

Lectures are held in Short Bros.' Canteen, Rochester, at 7 p.m.

Portsmouth Branch.

Thursday, Feb. 9th.—Lecture by Captain A. S. Wilcockson, O.B.E., on "Atlantic Crossings by Empire Boat."

Thursday, Feb. 16th.—Lecture by Mr. W. Hackett on "Modern Developments in Steel Tubes for Aircraft."

Thursday, Feb. 23rd.—Lecture by Mr. F. C. Lynam, A.F.R.Ae.S., A.F.I.Ae.S., on "Variable Pitch Airscrews."

Thursday, March 9th.—Lecture by Mr. G. Dring, B.Sc., M.A., F.I.C., "Plastics."

Lectures will be held at the Airspeed Club, Bowler Avenue, Copnor, at 7.30 p.m.

Southampton Branch.

Wednesday, Feb. 1st.—Lecture by Mr. C. G. James on "The Metallography of Aircraft Materials."

Wednesday, March 1st.—Lecture by Mr. D. Hollis Williams, B.Sc., F.R.Ae.S., on "The Tricycle Chassis."

Lectures will be held at Air Service Training Limited, Hamble, at 7.30 p.m.

Weybridge.

Wednesday, Feb. 22nd.—Lecture by Squadron Leader H. P. Fraser, A.F.R.Ae.S., on "Aircraft Controls from the Pilot's Viewpoint."

Lectures are held in Senior Staff Canteen, Vickers' Works, Weybridge, at 6.15 p.m.

Yeovil Branch.

Thursday, Feb. 2nd.—Lecture by Mr. John Hopcraft, A.M.I.Ae.E., on "Steel Manufacture."

Thursday, March 2nd.—Lecture by Mr. F. W. Burnard on "Lysander in India."

The following lectures have also been arranged:—

Wednesday, Feb. 1st.—Lecture by Commander R. R. Graham, R.N., before the Barking Abbey School, Essex, on "Bird Flight."

Wednesday, Feb. 15th.—Lecture by Mr. H. T. Winter (Founder Member), before the Fulham Public Library on "The History of the Aeroplane."

Friday, Feb. 17th.—Lecture by Mr. John Bell, A.R.Ae.S.I., on "Mapping a Country by Photography from the Air," before the Scientific Society of Rutherford College Boys' School, Newcastle-upon-Tyne 4.

Wednesday, Feb. 22nd.—Lecture by Mr. H. T. Winter (Founder Member), at Harrod's Book Department, on "A Trip into the Stratosphere."

Monday, Feb. 27th.—Lecture by Professor G. T. R. Hill, F.R.Ae.S., on "Stability and Control," before the Halton Engineering Society, Halton.

J. Laurence Pritchard, *Secretary and Editor.*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated The Institution of Aeronautical Engineers

MONTHLY NOTICES

MARCH, 1939

New Premises.

On March 25th, 1939, the Society will move to its new headquarters, No. 4, Hamilton Place, W.1.

Up to and including March 25th, 1939, all correspondence should be addressed to No. 7, Albemarle Street.

After that date correspondence should be addressed to No. 4, Hamilton Place, W.1.

The new telephone numbers will be GROsvenor 3515 and 3516.

Office Closing.

Except for correspondence the offices of the Society will be closed from Wednesday, March 22nd, 1939, until Tuesday, April 11th, 1939.

Annual General Meeting, March 29th, 1939.

The Annual General Meeting of the Society will be held at the **Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1** (by permission of the Council of the Institution), at 6.30 p.m., on Wednesday, March 29th, 1939. Notices will be sent to all members. It will be followed immediately by a Special Meeting to consider certain alterations to the rules.

ANNUAL GENERAL MEETING.

AGENDA.

1. To read the Notice convening the Meeting.
2. To receive and deliberate upon the Report of the Council on the state of the Society, and the Balance Sheets of Aerial Science Limited and Aeronautical Trusts Limited, as printed in the Journal of the Royal Aeronautical Society, with which is incorporated the Institution of Aeronautical Engineers, for March, 1939.
3. To receive the Report of the Scrutineers of the ballot for Council for the years 1939-41.
4. To elect the Auditors for the ensuing year for Aerial Science Limited and Aeronautical Trusts Limited.
5. To consider the grades of Membership and Associate Membership.
6. To consider any other business.

By Order of the Council,

J. LAURENCE PRITCHARD, *Secretary.*

SPECIAL GENERAL MEETING.

AGENDA.

1. To consider the following proposals put forward by the Council for alterations of the Rules.

   Rules 19 (*b*), 20 (*b*) and 25. That the word "three" should be altered to "five" in every case where it appears in these rules.

(The effect of the proposed alteration is to increase the experience required for Associate Fellowship and Associate Membership from three to five years.)

2. To consider a proposal that the present scale of compounding subscriptions should apply for members compounding within the first five years of joining and that the amount should be reduced by one guinea per annum for each year of membership after five years.

(This involves an alteration of the Appendix—Subscriptions in the Rules.)

By Order of the Council,

J. LAURENCE PRITCHARD, *Secretary.*

Nominations for Council.

Attention is drawn to Rules 68-85 regulating the constitution of the Council, and in particular to Rules 79 and 81, which read as follows:—

RULE 79.—One half of the Council (excluding the President and the Immediate Past-President if a Member of Council) shall retire annually. The members who shall retire shall be those longest in office, except as provided in Rule 85. Retiring members of Council who have served two terms in succession (four years) shall not be eligible for re-election until the next annual election, when they will be eligible.

RULE 81.—Nominations of candidates for election to the Council must be received by the Secretary not less than twenty-one days before the Annual General Meeting, with an intimation in writing by the candidates that they are willing to serve. Nominations must be signed by one supporter and two seconders, who must each be entitled to vote in the R.Ae.S.I.

Under Rule 105 the Annual General Meeting is held at some convenient date before the end of March of each year. Nominations must be received by March 8th at the latest.

Meeting of Council.

A Meeting of the Council was held on Wednesday, February 15th, 1939, in the Offices of the Society, 7, Albemarle Street, W.1.

Present: Mr. A. H. R. Fedden (President) in the chair; Mr. S. Camm, Dr. H. Roxbee Cox, Mr. W. C. Devereux, Mr. A. Gouge, Mr. F. Handley Page, Lieut.-Col. W. Lockwood Marsh, Dr. N. A. V. Piercy, Professor A. J. Sutton Pippard, Mr. H. E. Wimperis (Past-President), Mr. L. A. Wingfield (Solicitor).

Among the business discussed was the following:—Representation of the Society at Conferences; Report of the Finance Committee; Report of the Grading Committee; Appointment of Representatives to meet the Faculty of Engineering of the University of London; Report of the Medals and Awards Committee; Draft Annual Report of the Council.

Election of Members.

The following recommendations of the Grading Committee were approved by the Council at their meeting on February 15th, 1939:—

Fellow.—Ernest Walter Hives.

Associate Fellows.—Cyril Oswald Blakemore, James Phipps Booth (from Student), Joseph Raphael Crean (from Companion), Harold Ralph Day, Laurence Field, Kenneth Bryan Gillmore (from Student), Albert Claude Kidney, Robert Kronfeld, Roy James Nixon, Joseph Andrew O'Brien, Arthur Parkes, Demetrius George Samaras (from Graduate), James Godwin Strong, Alexander William Torry, Patrick Newton Vincent, Arthur Sidney Wilcockson.

Associate Members.—George Hobbs, Eustace Cecil Joseph O'Hanlon, Charles Henry Sexton.

Associates.—John Aherne-Heron, Harold Brown, Herbert William Leslie Calder, Alan Arthur Edward Clutten, Reginald Ernest Collins, Walter Stanley Hollyhock, William Jackson, Herbert Edgar Lewis, Alfred Osborne, Alan Gerald Peters, William George Wainwright-Fahey, Rowland Wilkinson, Harry Wright.

Graduates.—Leslie William Andrews, John Hanway Parr Brymer, Alfred John Lawrence Collinson, Ferdinand Basil Greatrex, John Leslie Hewitt, Frederick Alexander Nigel Hitch, Alexander Jardine (from Student), Eric Redgrave Owen (from Student).

Companions.—Beecher Boncroft Cary, Ivor William Jones, Henry William Masterton, Thomas McCowat, Philip Henry Riseley, F. Geoffrey Wayman.

Students.—John Elliston Allen, James Walter Agnezn Andrews, Nevil James Ashton, Ronald John Atkinson, Douglas Arthur Baker, Cecil Beardsley Baker, Richard Devon Bale, Frank Norman Bartlett Bennett, Alfred Peter Bond, Thomas Henry Cain, James Derek Evans, Eric Donald Govaars, Edward John Hidson, Shukry Kamel Ibrahim, Charles Henry Johns, John Glyn Jones, Horace Victor le Dieu, George Maurice Martin Magill, Hugh Eimai McCormick, Leo Anthony Mcquillan, Philip Evan Mitchell, Anthony Christopher Claude Packe, Ronald Ernest Penney, John Macgregor Lund Roberts, George Campbell Smith, Mieczyslaw Sokol, Ronald Wilfred Thomas, Donald Launcelot Turner, Hubert William van Rhyn, Geoffrey Verdon-Roe, Norman Stanley Watson, Joseph Yeates.

Associate Fellowship and Associate Membership Examination.

The next examinations will be held in London in May, 1939. Entry forms, obtainable from the Secretary, should be sent in with entrance fees not later than March 31st, 1939. Entries received after that date will not be considered valid.

Wilbur Wright Memorial Lecture.

The 27th Wilbur Wright Memorial Lecture will be given by Dr. G. W. Lewis, F.I.Ae.S., President of the Institute of the Aeronautical Sciences of America, on Thursday, May 25th, 1939. The lecture will be held at the Institution of Mechanical Engineers (by permission of the Council of the Institution), Storey's Gate, St. James's Park, S.W.1. Further particulars will be announced later.

Garden Party.

On Sunday, May 14th, 1939, the Royal Aeronautical Society will hold its Annual Garden Party at the Great West Aerodrome, near Hayes, Middlesex, which has been kindly lent by Mr. C. R. Fairey, M.B.E., F.R.Ae.S., for the occasion.

Details will be announced later.

Medals and Awards.

The following awards have been made by the Council of the Royal Aeronautical Society :—

Silver Medal.

To Major R. H. Mayo, O.B.E., M.A., Assoc.M.Inst.C.E., F.R.Ae.S., for his work leading to an advancement in aeronautical design.

The Silver Medal is awarded annually, at the discretion of the Council for some advance in aeronautical design.

Taylor Gold Medal.

To Squadron Leader H. P. Fraser, A.F.C., B.A., A.F.R.Ae.S., R.A.F., for his paper on " High Wing Loading and Some of its Problems from the Pilot's Point of View."

The Taylor Gold Medal is awarded annually, at the discretion of the Council, for the most valuable paper submitted or read during the previous session.

Wakefield Gold Medal.

To Mr. Leslie L. Irvin for his work on parachute design which has led towards safety in flying.

The Wakefield Gold Medal is awarded annually to the designer of any invention or apparatus tending towards safety in flying.

Busk Memorial Prize.

To Squadron Leader G. M. Buxton, R.A.F., for his paper on "The Development of Sailplanes," and to Mr. H. F. Vessey, A.F.R.Ae.S., for his paper on "Effect of Wing Loading on the Design of Modern Aircraft with Particular Regard to Take-off Problems."

The Edward Busk Memorial Prize is offered annually for the best paper received by the Society on some subject of a technical nature in connection with aeroplanes or seaplanes.

Pilcher Memorial Prize.

To Mr. H. E. H. Rochefort, Wh. Sch., A.C.G.I., D.I.C., for his paper on "The Theory and Practice of Stressed Skin Construction for Aeroplanes."

The Pilcher Memorial Prize is offered annually for the best paper by a student on heavier-than-air craft or any analogous subject.

Usborne Memorial Prize.

To Mr. P. H. Rayner, B.Sc., for his paper on "Notes on Aero Engine Research."

Awarded annually for the best paper by a Student on aero engines.

Joint Meeting with other Institutions.

A Joint Meeting organised by the Institution of Automobile Engineers in conjunction with the various Societies will be held on Friday, 10th March, 1939, at 7.0 p.m., in the Great Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1, when the following papers will be introduced and discussed:—"Factors Contributing to Comfort in Travel."

Section 1—By Road—by Mr. Sidney Garcke, M.I.Mech.E. (Executive Director of British Electric Traction Co., Ltd.).

Section 2—By Rail—by the Rt. Hon. Lord Stamp, G.C.B. (Chairman, L.M.S. Rly.).

Section 3—By Air—by Capt. E. W. Percival, M.I.Ae.E. (Percival Aircraft, Ltd.).

The chair will be taken by the Rt. Hon. Lord Ashfield.

Time-Table.

7.0—7.15 p.m.—Introduction of Chairman.
7.15—8.15 p.m.—Introduction of Papers and commencement of discussion.
8.15—8.45 p.m.—Interval for light refreshments.

World Automotive Engineering Congress.

New York, May 22—May 28.
Indianapolis, May 30.
Detroit, May 31—June 2.
San Francisco, June 6—June 8.

The World Automotive Engineering Congress, organised by the Society of Automotive Engineers (U.S.A.) will take place in New York, Indianapolis, Detroit and San Francisco, May 22 to June 8, 1939. A cordial invitation is extended to engineers of every foreign country to take part in the proceedings.

The 16-day programme of the Congress opens in New York (May 22-28) with five days of technical sessions devoted to passenger cars, passenger car bodies, commercial vehicles, aircraft, aircraft engines, Diesel engines and farm tractors. Two days will be spent in visiting points of interest in and about the city. One scheduled trip will include such traffic developments as the motor vehicle tunnels under the Hudson River, the new George Washington and Triboro Bridges, and elevated highways in New Jersey and New York.

The New York World's Fair, at which many of the American automotive companies will have educational exhibits, will also be on the programme of tours.

From New York the delegates will travel to Indianapolis and the Congress will then proceed to Detroit for three days (May 31st-June 2nd) of inspection trips to America's automobile factories, an international dinner and a technical session. Arriving in San Francisco by way of Los Angeles, June 6th, the Congress will devote three days to technical sessions. The Congress will close June 8th with a banquet in San Francisco.

Full particulars of the Congress may be obtained from the Secretary, Society of Automotive Engineers, 29 West 39th Street, New York, U.S.A., or from local agents of the American Express Company, anywhere in the world.

The Institute of Petroleum Summer Meeting.

The Summer Meeting of the Institute of Petroleum will be held in Birmingham from May 22-24, 1939. Members of the Society are invited to attend the meeting, and full particulars may be obtained from the Secretary of the Institute at The Adelphi, London, W.C.2.

Additions to Library—February, 1939.

Aeronautical Research Committee, Reports and Memoranda:—

No. 1835. Airscrew Blade Vibration, by J. Morris. (H.M.S.O., 4/-.)

No. 1838. The Calculation of the Profile Drag of Aerofoils, by H. B. Squire and A. D. Young. (H.M.S.O., 4/-.)

No. 1841. Hydraulic Operator for Remote Balance Control, by A. S. Halliday and C. H. Burge. (H.M.S.O., 1/-.)

Meteorological Office, Professional Notes:—

No. 85. The Relation between the Blueness of the Sky and (A) The Polarity of the Air, (B) The Gradient Wind, by J. H. Brazell. Observations of the blueness of the Sky at Aberdeen, Valentia and Kew, by J. S. Farquharson. (H.M.S.O., 2d.)

National Advisory Committee for Aeronautics, Reports:—

No. 635. Theoretical Stability and Control Characteristics of Wings with Various Amounts of Taper and Twist, by H. A. Pearson and Robert T. Jones.

No. 636. Approximate Stress Analysis of Multi-Stringer Beams with Shear Deformation of the Flanges, by Paul Kuhn.

No. 641. The Negative Thrust and Torque of Several Full-Scale Propellers and Their Application to Various Flight Problems, by E. P. Hartman and David Bierman.

No. 643. The Aerodynamic Characteristics of Four Full-Scale Propellers having Different Plan Forms, by E. P. Hartman and David Bierman.

National Advisory Committee for Aeronautics, Technical Notes:—

No. 662. Gyroscopic Instruments for Instrument Flying, by W. G. Brombacher and W. C. Trent.

No. 663. The Effects of Partial-Span Plain Flaps on the Aerodynamic Characteristics of a Rectangular and a Tapered Clark Y Wing, by R. O. House.

No. 664. Free-Spinning Wind Tunnel Tests of a Low-Wing Monoplane with Systematic Changes in Wings and Tails, by Oscar Seidman and A. I. Neihouse.

No. 665. Tests of N-85, N-86 and N-87 Airfoil Sections in the 11-inch High Speed Wind Tunnel, by John Stack and W. F. Lindsey.

No. 666. Longitudinal Stability in Relation to the Use of an Automatic Pilot, by Alex. Klemin, P. A. Pepper and H. A. Wittner.

No. 667. Operational Treatment of the Non-Uniform Lift Theory in Aeroplane Dynamics, by Robert T. Jones.

No. 668. Hydrodynamic and Aerodynamic Tests of Models of Flying Boat Hulls Designed for Low Aerodynamic Drag, by S. Truscott, J. B. Parkinson, J. W. Ebert, Jr., and E. Floyd Valentine.

No. 669. The Drag of Inflatable Rubber De-Icers, by R. G. Robinson.

No. 670. N.A.C.A. Stall Warning Indicator, by F. L. Thompson.

No. 671. A Method of Rapidly Estimating the Position of the Laminar Separation Point, by A. E. von Doenhoff.

No. 672. Flow Observations with Tufts and Lampblack of the Stalling of Four Typical Airfoil Sections in the N.A.C.A. Variable Density Tunnel, by Ira H. Abbott and Albert Sherman.

National Advisory Committee for Aeronautics: Twenty-Fourth Annual Report, 1938.

Mitteilungen aus dem Institut für Aerodynamik (Eidgenössische Technische Hochschule, Zürich):—

No. 4. Experimentelle Untersuchungen über Flügelschwingungen. Von H. L. Studer.

No. 5. La Portance et la Trainée induite minimum d'une Aile au Voisinage du Sol. P. de Haller.

Rensselaer Polytechnic Institute Bulletins:—

No. 85. The Value of History in Engineering Education, by H. W. Dickinson.

No. 86. Amos Eaton as a Chemist, by H. S. Van Klooster.

Publications of R. Politecnico di Torino, Laboratorio di Aeronautica:—

No. 108. Bilancie Aerodinamiche a sei Componenti. M. Panetti.

No. 110. Sistemazioni elettriche per lo Studio sperimentale della Dinamica dei Fluidi. C. Ferrari.

No. 111. Ricerche particolari riguardo all'Impiego dell'Alcool etilico nei Motori veloci ad Iniezione ed a Carburazione. A. Capetti.

No. 112. Il Problema aerodinamico del Volo ad Ala battente. P. Cicala.

No. 113. Ricerche sperimentali sulle azioni aerodinamiche sopra l'Ala oscillante. P. Cicala.

No. 114. Ricerca grafica dei Coefficienti di Resistenza e di Momento idrodinamico di un Idroscivolante munito di Ala e Determinazione dei Calettamenti ottimi Ala-Scafo. E. Lorenzelli.

Publications Scientifiques et Techniques du Ministère de l'Air:—

B.S.T. No. 83. Aérodynamique Expérimentale. Vol. 1. R. Pris.

B.S.T. No. 83 bis. Ditto. Vol. 2.

Thomson-Houston Instruction Booklets:—

No. 1407. Type AG. 4 Magnetos.

No. 1490. Ignition Equipment Used on Gipsy Six Engines.

No. 1491. Lightweight Air Compressors. AV-Single Cylinder, AW-Double Cylinder.

No. 1515. Speed Indicating Equipment, Type L (D.H. Engines).

No. 1516. Hand-Starter Magnetos.

No. 1525. Aircraft Magnetos (MI-1 and MI-2).

(All the above, except No. 1491, printed in English, French and Spanish.)

Meteorological Organisation for Airmen. (M.O.A. Pamphlet No. DGO 28 39/800, published by India Meteorological Dept., Poona, 1939.) 1/9.

Académie des Sciences. Reprints of Lectures by Mr. D. Riabouchinsky :—

1. Méthode Puits-Tourbillonnaire d'Hypersustentation et de Diminution de la Trainée.
2. Ondes hypersoniques dans les Gaz.
3. Comparaison de la méthode des Variables ϕ, ψ_1, ψ_2, t, à celles des Variables d'Euler et de Lagrange.
4. Équations approchées des Mouvements trois-dimensionnels d'un Fluide parfaitement compressible.

Transactions of the Chartered Institute of Patent Agents. Volume LVI, 1937-38.

Académie des Sciences : Bulletin Bibliographique des Publications périodiques reçues pendant l'année 1937.

Commission Internationale de la Navigation Aérienne. (I.C.A.N.) Carnet de Signaux à l'usage de la Navigation aérienne, établi conformément à la Convention aérienne de 1919 et au Code international de Signaux. 1939. 40 Frs.

Aéro Club de France, Bibliothèque. (Library Catalogue) 1922 (with supplements to 1930).

XVIe Salon de l'Aviation, Paris. Catalogue Officiel. 1938. 5 Frs.

Aeronautical Meteorology, by George F. Taylor. Pitman's. 18/-.

Airport Lighting. U.S. Civil Aeronautics Authority (Bulletin No. 10). Pamphlet. 1938.

The British Aircraft Industry. Society of British Aircraft Constructors, 1939.

Civil Aviation as a Career. By T. Stanhope Sprigg. George Newnes. 1939. 5/-.

Deutsche Luftfahrtforschung Jahrbuch 1938, Ergänzungsband. R. Oldenbourg Verlag, Munich.

The Early History of Air Transportation. (Pamphlet.) By E. P. Warner, Norwich University, Northfield (Vermont), U.S.A.

Engineering Applications of Aerial and Terrestrial Photogrammetry. By B. B. Talley. Pitman's. 1939. 32/6.

An Experimental Study of the Voussoir Arch. By A. J. S. Pippard and R. J. Ashby. The Institution of Civil Engineers. 1939. (Pamphlet.)

Flugzeugbau und Luftfahrt, Heft 29, Teil 1 : Die Wartung des Triebwerks. By Cl. Böhne. Volckmann, Berlin. 1938. RM. 3.00.

Flugzeug-Typenbuch : Jahrgang, 1937-38. By H. Schneider. Herm. Beyer Verlag, Leipzig.

Fortschritte in Luftfahrt und Flugtechnik. By Walter Zuerl. Pechstein, Munich. 1938.

Getting a Job in Aviation. By Carl Norcross. McGraw Hill. 1938. 15/-.

Handbook on Construction of Propellers. (HB. 302.) Ministry of Munitions. 1918.

Handbook of Strength Calculations. By A. J. S. Pippard and J. L. Pritchard. (HB. 806.) Ministry of Munitions. 1918.

International Aeronautic Organisations and the Control of Air Navigation. (Pamphlet.) By J. J. Ide. Norwich University, Northfield (Vermont), U.S.A. 1935. (Revised, 1938.)

Light Aluminium Alloys containing Nickel (Bibliography). Pamphlet. Mond Nickel Co., Ltd. 1938.

Neue Wege der Flugtechnik. By H. Focke. V.D.I. Verlag, Berlin. 1938. RM. 0.90.

La Place de l'Aviation Commerciale Française dans le Transport par Air Mondial. By Robert Boname. (Reprint of Lecture.) L'Aéro Club de France. 1938.

Probleme des Flugzeugantriebes in Gegenwart und Zukunft. By J. Ackeret. Institut für Aerodynamik, Zürich. 1938. (Reprint.)

Pure Mathematics. (A general course of Pure Mathematics, from Indices to Solid Analytical Geometry.) By Arthur L. Bowley. Clarendon Press. 1913.

Rapid Navigation Tables. By W. Myerscough and W. Hamilton. Pitman's. 1939. 10/6.

The Soaring Cycle. (Typewritten Memorandum.) The Soaring Flight Co., Washington, U.S.A. 1939.

Trade Marks. By Reginald Haddan. Pitman's. 1938. 5/-.

Ueber den Kraftverlauf in längs- und querversteiften Scheiben. By H. Ebner and H. Köller. (Reprint of Lecture.) D.V.L., Berlin. 1938.

Das Verschwindfahrwerk: Bauart, Wirkungsweise, Bauelemente. By Walter Zuerl. Pechstein, Munich. 1938. (Vol. 4 of series, "Luftfahrt und Flugtechnik.")

Zur Festigkeit von Schalen- und Rohrholmflügeln. By H. Ebner. (Reprint of Lecture.) D.V.L., Berlin. 1937.

Forthcoming Events.

March 2nd.—Lecture before the Society by Ir. A. G. von Baumhauer, F.R.Ae.S., on "Testing Stability and Control of Aeroplanes," at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1 (by permission of the Council of the Institution). Light refreshments will be served from 6 p.m.

March 10th.—Joint Meeting with the Institution of Automobile Engineers and other Institutions on "Comfort in Travel," at 7.0 p.m., in the Great Hall of the Institution of Civil Engineers, Great George Street, S.W.1.

Section 1—By Road. Section 2—By Rail. Section 3—By Air.

March 14th.—Finance Committee Meeting in the Society's Offices at 5.30 p.m.

March 15th.—Council Meeting in the Society's Offices at 5.30 p.m.

March 16th.—Lecture before the Society by Mr. J. E. Ellor, F.R.Ae.S., and Mr. F. M. Owner, M.Sc., F.R.Ae.S., on "Review of the Relative Merits of Carburettors and Direct Petrol Injection for Aero Engines," at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers.

March 22nd.—Society's Offices at 7, Albemarle Street, close.

March 29th.—Annual General Meeting at the Institution of Mechanical Engineers, Storey's Gate, S.W.1, at 6.30 p.m.

March 30th.—Lecture before the Society by Mr. F. Nixon, B.Sc., A.F.R.Ae.S., and Mr. R. H. Chaplin, B.Sc., A.F.R.Ae.S., on "The Problem of Ancillary Power Services on Aircraft," at 6.30 p.m., at the Institution of Mechanical Engineers.

April 11th.—4, Hamilton Place opens.

GRADUATES' AND STUDENTS' SECTION.

March 7th.—Lecture on "Plastics," by Mr. M. Langley, A.M.Inst.N.A., M.I.Ae.E., at 7 p.m., in the Society's Library, 7, Albemarle Street, W.1. Refreshments will be served from 6.0 p.m.

March 18th.—Visit to the New Wind Tunnel and Testing Laboratory, Fairey Aviation Company, Limited, Hayes, Middlesex, at 2.30 p.m.

March 21st.—Lecture on "The Limitation of Aircraft Speeds by Compressibility," by Mr. W. F. Hilton, Ph.D., D.I.C., A.F.R.Ae.S., at 7.0 p.m. Mr. E. F. Relf, F.R.S., F.R.Ae.S., in the chair.

Lectures before Branches.

Belfast Branch.

Tuesday, March 14th.—Mr. J. G. Hopcraft, M.C., A.M.I.Ae.E., Film on Steelmaking with commentary.

Lectures are held in the Central Hall of the College of Technology, Belfast, at 7.45 p.m.

Isle of Wight.

Tuesday, March 14th.—Debate (subject to be announced later).

Lectures are held at 6.30 p.m. in the Lecture Room at Columbine Works, Messrs. Saunders-Roe, Cowes.

Manchester Branch.

Thursday, March 9th.—Lecture by Captain A. S. Wilcockson on "North Atlantic Flights."

Medway Branch.

Monday March 6th.—Lecture by Captain A. S. Wilcockson, on "Atlantic Air Routes."

Lectures are held in Short Bros.' Canteen, Rochester, at 7 p.m.

Portsmouth Branch.

Thursday, March 9th.—Lecture by Mr. G. Dring, B.Sc., M.A., F.I.C., "Plastics."

Thursday, March 16th.—Lecture by Mr. M. B. Morgan, B.A., on "Flying Controls."

Thursday, March 23rd.—Lecture by Mr. H. Roxbee Cox, Ph.D., D.I.C., B.Sc., F.R.Ae.S., on "Future Development of Aircraft Construction."

Lectures will be held at the Airspeed Club, Bowler Avenue, Copnor, Portsmouth, at 7.30 p.m.

Southampton Branch.

Wednesday, March 1st.—Lecture by Mr. D. Hollis Williams, B.Sc., F.R.Ae.S., on "The Tricycle Chassis."

Wednesday, April 5th. Lecture by Mr. M. S. Hooper, F.R.Ae.S.

Weybridge Branch.

Wednesday, March 22nd.—Lecture by Mr. N. S. Muir, B.Sc., A.F.R.Ae.S., on "Some Aspects of Flight Testing of Engines."

Wednesday, April 12th.—Lecture by Mr. G. H. Miles, D.Sc., on "The Human Factor in Production."

Lectures are held in Senior Staff Canteen, Vickers' Works, Weybridge, at 6.15 p.m.

Yeovil Branch.

Thursday, March 2nd.—Lecture by Mr. F. W. Burnard on "Lysander in India."

J. LAURENCE PRITCHARD, *Secretary and Editor*

THE
ROYAL AERONAUTICAL SOCIETY
With which is incorporated The Institution of Aeronautical Engineers
No. 4, Hamilton Place, London, W.1. Telephones: Grosvenor 3515/6.

MONTHLY NOTICES
APRIL, 1939

No. 4, Hamilton Place.

At the Annual General Meeting of the Royal Aeronautical Society the President, Mr. A. H. R. Fedden, M.B.E., D.Sc., M.I.A.E., M.S.A.E., F.R.Ae.S., announced that the Society had, during the last few days, moved into new headquarters at No. 4, Hamilton Place, W.1, at the bottom of Park Lane. It was, he explained, a major event in the history of the Society, as for the first time during its 73 years of existence, it had acquired its own building, a building worthy of its long tradition. No. 4, Hamilton Place is a four-storey building which, it is expected, will allow for the expanding activities of the Society for some years to come. It will enable the Society to hold many of its chief functions in its own home. The Library will be undoubtedly one of the finest and best equipped aeronautical libraries in the world. There will be in addition a reading and other rooms for members and committee rooms for the use of the many aeronautical committees which are now sitting. It is hoped to make No. 4, Hamilton Place the centre of aeronautical engineering and scientific activities in this country, a task which was not possible in its old headquarters. The new headquarters will be open to members on Tuesday, April 11th.

Garden Party.

Arrangements are well in hand for the Society's Annual Garden Party which will be held on Sunday, May 14th, 1939, at the Great West Aerodrome, near Hayes, Middlesex, by kind permission of Mr. C. R. Fairey, M.B.E., F.R.Ae.S., Past-President.

Among the machines for which arrangements are being made to show or demonstrate are the following:—

Blackburn Skua, Boulton Paul Defiant, Chilton Monoplane, Cierva Autogiro C40. De Havilland Frobisher and Moth Minor, Fairey P4/34 and Battle, General Aircraft Cygnet and Experimental Pressure Cabin Machine, Lockheed 14, Luton Major and Buzzard, Miles Master, Percival Q6, Vega Gull and Mew Gull, Westland Lysander II, Willoughby Delta St. Francis, Hawker Hurricane I, and Healey, Hurricane and Wellington, Handley Page Hampden, and a number of historical machines, Sopwith Camel, Bleriot, Duperdussion, etc.

A number of other machines are under consideration.

A large number of firms are also helping to make the Static Display representative of the many sides of aviation.

Annual General Meeting.

At the Annual General Meeting held on March 29th, 1939, a Resolution was proposed and carried that the Council should draft the necessary Rules to abolish the grades of Membership and Associate Membership and that existing Members and Associate Members should be transferred to the Fellowship and Associate Fellowship grades respectively.

A Resolution was also passed recommending to the Council that the Rules for Associate Fellowship should be amended so that those with long experience in aviation and who have reached positions of responsibility may be eligible for election, though they have not passed the Associate Fellowship examination nor an exempting examination.

Notice of a Special Meeting to amend the Rules will be sent to all members as soon as the necessary alterations have been prepared.

Special General Meeting.

At the Special General Meeting held on March 29th, 1939, it was agreed to amend Rules 19 (*b*), 20 (*b*) and 25 to increase the experience required for Associate Fellowship and Associate Membership from three to five years.

The question was raised at the meeting whether this would apply to present Students, Graduates, and those who have already passed the Associate Fellowship and Associate Membership examinations. It was agreed that the alterations would only apply to those who became Students or Graduates after March 31st, 1939. Those who are now Students or Graduates or have passed the Associate Fellowship or Associate Membership examinations will come under the three-year qualification.

Wilbur Wright Memorial Lecture.

The 27th Wilbur Wright Memorial Lecture will be given by Dr. G. W. Lewis, F.I.Ae.S., President of the Institute of the Aeronautical Sciences, on Thursday, May 25th, 1939. The subject of the lecture will be " Some Modern Methods of Research in the Problems of Flight."

The lecture will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, at 6.30 p.m. (by permission of the Council of the Institution), and will be followed by the Annual Council Dinner at No. 4, Hamilton Place, W.1.

Elections to Council.

The following members of Council were elected to the Council for the years 1939-1941 :—

Captain P. D. Acland, *Companion.*
Mr. D. L. Ellis, B.Sc., A.R.T.C., *Associate Fellow.*
Captain F. T. Hill, *Fellow and Member.*
Air Vice-Marshal R. M. Hill, M.C., A.F.C., *Fellow.*
Lieut.-Colonel W. Lockwood Marsh, LL.B., A.F.I.Ae.S., M.I.A.E., *Fellow.*
Lieut.-Colonel J. T. C. Moore-Brabazon, M.C., M.P., *Fellow.*
Major B. W. Shilson, O.B.E., M.I.Mech.E., M.I.A.E., F.R.G.S., *Fellow.*
Mr. F. M. Thomas, *Associate Fellow.*
Dr. H. C. Watts, M.B.E., M.Inst.C.E., *Fellow.*
Mr. R. T. Youngman, B.Sc., *Fellow.*

Council Meeting.

A meeting of the Council was held on Wednesday, March 15th, 1939, in the Offices of the Society.

Present: Mr. A. H. R. Fedden (President) in the chair; Professor L. Bairstow, Mr. S. Camm, Mr. H. Roxbee Cox, Mr. W. C. Devereux, Mr. A. Gouge, Mr. A. H. Hall, Professor G. T. R. Hill, Major D. H. Kennedy (Honorary Treasurer), Lieut.-Colonel W. Lockwood Marsh, Dr. N. A. V. Piercy, Professor A. J. Sutton Pippard, Mr. D. R. Pye, Mr. L. A. Wingfield (Solicitor).

Among the business discussed was the following:—Society of Automotive Engineers Conference in America; Report of the Finance Committee; Report of the Grading Committee; Memorandum on the Journal of the Society; Memorandum on Membership; Appointment of Scrutineers for the Council Ballot.

Election of Members.

The following members were elected at the meeting of Council held on March 15th. 1939:—

Honorary Fellow.—Lester Gardner (formerly Associate Fellow).

Fellow.—John Dunbar Blyth (from Associate Fellow and is also a Member).

Associate Fellows.—Alfred William Barr, Raymond Noel Dorey, Reginald Ernest Gustine (from Associate), Robert Henry Travell Harper, Suljames Robert Lewis (from Student), Wynand Johannes Pretorius (from Student), William Eliezer Prytherch, Miss Grace Mary Bruce Quennell (from Student), Ernest William Still, Frederick William Wardley.

Associate Members.—Henry Richard William Frost, George Henry Hull.

Associates.—Laurence Percival Burch, William Bertram Coles, William Russell Livingstone, George Arthur Grindell Morris.

Graduates.—Thomas Marcel Blanch, George Percy Jewell (from Student), Frank Marshall Reynolds.

Companions.—Syed Nagui Bilgrami, H. J. Wolffsohn.

Students.—Thomas Barrow. James Arthur Chamberlin, Walter Leonard Clarke, Arthur Wickman Coney, Frederick Cormack, Peter Linton Cronbach, Alfred Maurice ffoulkes, Gordon Fryer, Basil Jackson, David Sadler, John Henry Francis Scrope, Trevor Hetherington Tarr, Wilfred Kenneth Tedham, Stuart Spencer Wyllie, Wilfred Charles James Garrard.

Annual Subscriptions.

Under the Rules, members who have not paid their subscriptions for the current year by April 1st are not entitled to have the JOURNAL sent to them. It is not always possible to send back numbers of the JOURNAL to those who pay their subscriptions some time after April 1st, as many of the JOURNALS go out of print.

The Council wish to thank all those members who have been prompt in paying their subscriptions. By the members supporting the Society in this way it is possible to legislate ahead and make arrangements which effect considerable saving against having to work from month to month.

Australasian Branch.

During the 1938 Session the Branch and the Aeronautical Engineering Branch of the Institution of Engineers, Australia, worked together by holding conjoint committee and general meetings. The arrangement proved to be very satisfactory.

The following general meetings were held:—

Date. Paper and Author.

30th March.—" The Aeroplane and the Development of Australian Communications," by A. G. Berg, B.E., A.F.R.Ae.S.

12th May.—" Aerial Surveying and Photography," by Capt. F. W. Follett, Adastra Airways.

23rd June.—" Where Are We Going," by L. J. Reynolds, B.E., a paper dealing with the necessity for the aerial defence of Australia and methods of achieving the necessary rapid expansion of the aircraft industry.

28th July.—1. " Some Boundary Layer Experiments," by Flt. Lieut. J. O. Dibbs. B.E., and A. V. Doust, B.E.

2. " A New Form of Yaw Meter," by T. F. C. Lawrence, B.Sc., B.E., and I. L. Pinkerton, B.Sc., B.E.

3. "A Practical Stall Indicator," by C. Murray-Waller, A.R.Ae.S.I.

The first two papers dealt with some researches carried out by the authors, who were fourth year students during 1937.

25th August.—"The Development, Construction and Operation of Parachutes," by B. H. Turner, of Light Aircraft Pty., Ltd.

22nd September.—"Radio Equipment for Aircraft," by W. W. Honner, B.Sc., B.E., Amalgamated Wireless (Australasia), Ltd.

27th October.—"The Art of Flying and Flying Training," by Flt. Lieut. G. S. Coleman, Chief Instructor, The Royal Aero Club of N.S.W.

24th November.—"Meteorological Aids to Navigation," by A. C. White, Commonwealth Meteorological Services.

Income Tax.

In response to numerous inquiries with regard to a rebate on Income Tax for their subscriptions, the following is a copy of a letter received from the Principal Inspector of Taxes:—

"Ref. H.R.S. 34/C.I. 4420/63. 18/8/28.

Dear Sir.—Further to your interview with Mr. Stoneley at this office on the 19th July, I am now in a position to inform you that the Board of Inland Revenue will not raise objection to the allowance as an expense for Income Tax purposes of annual subscriptions paid by members who are:—

(i) Assessable under Schedule D of the Income Tax Acts in respect of professional or trading profits, subject to the decision of the Commissioners who make the assessment that such subscriptions are sufficiently closely related to the business carried on; or

(ii) Assessable under Schedule E in those cases only in which continual membership of the Society is an essential condition of the terms of appointment.

Yours faithfully,

(Signed) GEO. WILCOCK,

Principal Inspector of Taxes."

Acknowledgments.

The Council acknowledge with grateful thanks the return of Journals from Miss L. Chitty, Fellow, and a copy of "Flying," of December, 1901, presented to the Library by Mr. F. R. Simms, M.I.Mech.E., Founder Member and Member.

Fuels and Lubricants for Internal Combustion Engines.

The Institute of Petroleum are holding a meeting on the above subject in Birmingham from May 22nd-24th, 1939. Members of the Society are invited and full particulars may be obtained from the Secretary of the Institute of Petroleum, The Adelphi, W.C.2.

Additions to Library.

Publications Scientifiques et Techniques du Ministère de l'Air:—

No. 136. Contribution a l'étude des roues hélico-centrifuges de Turbo-Machines. M. Sédille. Frs. 20.

No. 137. Contribution a l'étude expérimentale des mouvements hydrodynamiques à deux dimensions. Alex. Favre. Frs. 50.

No. 138. Recherches théoriques et expérimentales sur les moyens de soustraire un avion aux accélérations que peuvent engendrer les perturbations atmosphériques. R. Hirsch. Frs. 35.

No. 139. Partage de la Chaleur entre deux corps frottants. F. Charron. Frs. 12.
No. 140. Stabilité des entonnoirs et des trombes. H. Bouasse. Frs. 20.
No. 141. Technique des essais de modèles d'avions complets. R. Silber. Frs. 25.
No. 142. Quelques applications des spectres d'absorption infra-rouges à l'étude des constituants des essences. J. Lecomte and P. Lambert. Frs. 30.
B.S.T., No. 84. Étude d'un banc-balance mesureur de couple. R. Silber and A. Oudart. Frs. 10.

Publications de l'Université de Lille :—

No. 16. Les installations de l'Institut de Mécanique des Fluides de Lille.
No. 17. Ce que furent les Journées Scientifiques et Techniques de Mécanique des Fluides.
No. 28. La turbulence atmospherique. By J. Kampé de Fériet.
No. 33. Sur les équations de la diffusion thermique par turbulence. J. Kampé de Fériet.
No. 38. Sur la determination des trajectoires des particules dans l'écoulement à travers une pompe centrifuge. Pierre Dupuis.
No. 39. Les bases d'une mécanique de la turbulence. J. Kampé de Fériet.
No. 42. La turbulence atmosphérique. J. Kampé de Fériet.
No. 44. Sur la répartition entre le mouvement moyen et le mouvement d'agitation de l'énergie dissipée dans l'écoulement turbulent d'un fluide incompressible. J. Kampé de Fériet and A. Martinot-Lagarde.
No. 45. La soufflerie verticale de l'Institut de Mécanique des Fluides de Lille et l'étude de la vrille des avions. J. D. Vâgner.
No. 49. Sur un appareil permettant de déterminer le module et la direction de la vitesse dans un fluide. J. Kampé de Fériet, A. Martinot-Lagarde and G. Rollin.
No. 50. Sur la vitesse moyenne en suivant le mouvement dans un fluide en écoulement turbulent. R. Duchêne and A. Martinot-Lagarde.
No. 51. Sonde de pression statique. J. Kampé de Fériet and G. Rollin.

India Meteorological Dept. Scientific Notes :—

Vol. VII, No. 79. Atmospheric electric potential gradient, conductivity and air-earth current on electrically " quiet " days at Colaba. S. M. Mukherjee. 2/-.

Atti di Guidonia :—

No. 1. Il carroponte dinamometrico della vasca idrodinamica di Guidonia. C. Cremona.

Patents for Inventors : Abridgments of Specifications :—

Class 7, Air and Gas Engines. (From 1855 to 1908 inclusive.) 2/- each volume.
Class 7, Divisions I-VI (1909-1915). 2/- each volume.
Class 7, Divisions II-VI (1916-1920). 2/- each volume.
Aircraft and Ships (Nos. 460,001-480,000). 2/-.

Admiralty Weather Manual, 1938. H.M.S.O. 10/6.
Aircraft and Engine Data Book. Various Authors. McGraw Hill.
Approved List of Translators and Interpreters. Institute of Linguists.
Arbeitsgerichtsgesetz, 23/12/26. Dr. Hans Depene. No. 168 of series " Guttentagsche Sammlung Deutscher Reichsgesetze," pub. De Gruyter, Berlin.
Art of Soaring Flight. Wolf Hirth (translated by Naomi Maxwell). " Sailplane and Glider," 1938. 5/-.
B.M.W. Flugmotoren. Bayerische Motorenwerke, Munich. 1928.

Deutsche Handelsluftfahrt. Otto Merkel. Reprint from " Verkehrstechnische Woche " Heft 51-52. 1926.

Der Deutsche Luftverkehr. Dr. E. Kredel. S. Hirzel, Berlin, 1931.

Die Deutsche Luftwaffe. Edited by Dr. Kürbs. Junker und Dunnhaupt. 1936.

La Dinamica delle Macchine Aeree. R. Verduzio. Libreria di Scienze e Lettere, Roma. 1924.

The Energy Balance Sheet of the Internal Combustion Engine. F. W. Lanchester. (Pamphlet.) Institute of Mechanical Engineers.

Ernährung und Teuerung. Edited by Ministerium des Innern. Gebhardt, Jahn and Landt, Berlin. 1916.

Examples and Charts for Aircraft Draughtsmen. H. Parkinson. Pitman's. 1939. 6/-.

Flugzeugabbildungen (Ausgabe B). Reichsdrückerei, Berlin. 1918.

Flugzeugnavigation und Luftverkehr. H. Röder. Hörisch, Dresden. 1927.

Gasschutz tut Not. Ernst Gillert. (Pamphlet.) 1927.

Heat-Resisting Steels. Dr. W. H. Hatfield. Reprint of paper read to Institute of Fuels, 24/3/38.

Handbook for Use with the Browning Gun. (A.P. 1548.) Air Ministry, 1936.

History of British Aviation. R. Dallas Brett. John Hamilton, Ltd. 1933. 21/-.

Icarus: An Anthology of Poetry of Flight. Edited by R. de la Bère. Macmillan and Co. 1939. 7/6.

The Industrial Arts Index, Vol. XXVI. H. W. Wilson, New York. 1939.

Internationales Luftfahrtrecht. Dr. R. Sleicher. De Gruyter, Berlin. 1923. (Pamphlet.)

The King's Air Force. Edited by C. Winchester. Amalgamated Press. 1937. 6d.

Lebensfragen der deutschen Luftfahrt. O. Blum and C. Pirath. Kohlhammer. Stuttgart. 1928.

Ligera Historia de la Aviación Española. Don I. Jimenez. Manila Grafica, Madrid. 1935. (Reprint of Lecture.)

Luftelektrische Untersuchungen bei Flugzeugaufsteigen. Dr. A. Wigand. (Vol. 18, No. 5 of series " Fortschritte der Chemie.") Bornträger, Berlin. 1925.

Mr. Lunardi's Own Account of his Aerial Flight. (Original Pamphlet dated 1784.)

Junkers and World Aviation. Fischer von Poturzyn. (Translated by E. Morley.) R. Pflaum, Munich. 1934.

The Old Flying Days. C. C. Turner. Sampson Low and Marston. 25/-.

The Pilot's Manual. Various authors. McGraw Hill. 1939.

Practical Aircraft Stress Analysis. (2nd Edition.) D. R. Adams. Pitman's. 1938. 8/6.

A Rabbit in the Air. David Garnett. Chatto and Windus. 1932.

Steam Generators. D. W. Rudorff. Chas. Griffin and Co. 1938.

Random Notes on a Visit to the U.S.A. and Australasia. W. S. Shackleton. Reprint from " The Aeroplane." 1937.

Technische Index: Jahrbuch der technischen Literatur. H. Rieser. Stephenson, Vienna. 1921.

International Index to Aeronautical Technical Reports. Edited by Society of British Aircraft Constructors. Pitman's. 1939. 5/-.

Verpackung und Versand von Postpaketen. (No. 45 of series " Reichskuratorium für Wirtschaftlichkeit.") Beuth-Verlag, Berlin. 1929.

Die Wirkung der Berge auf eine sie übersteigende Luftsäule. Vol. 5, No. 3 of series " Beiträge zur Physik der freien Atomsphäre.") Dr. K. Wegener. Otto Nemnich, Leipzig.

Wirtschaftliche Luftfahrt. H. Röder. Hörisch, Dresden. 1929.
Ueber die grosse Wirtschaftlichkeit des Luftschiffverkehrs und des Bauens von Luftschiffen. Dr. Schwengler. Landeszeitung, Neustrelitz. 1929.

Forthcoming Events.

April 11th.—4, Hamilton Place opens.

April 19th.—Council Meeting at 5.30 p.m.

April 20th.—Dr. Swinden's lecture *cancelled*.

May 4th.—Lecture before the Society by Mr. H. L. Cox on "Strength of Thin Metal Construction," at 6.30 p.m. in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1 (by permission of the Council of the Institution). Light refreshments will be served from 6 p.m.

May 14th.—**Garden Party.**—On Sunday, May 14th, 1939, the Royal Aeronautical Society will hold its Annual Garden Party at the Great West Aerodrome, near Hayes, Middlesex, which has been kindly lent by Mr. C. R. Fairey, M.B.E., F.R.Ae.S., for the occasion.

May 25th.—Wilbur Wright Memorial Lecture. Dr. G. W. Lewis, F.I.Ae.S., on "Some Modern Methods of Research in the Problems of Flight." The lecture will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1.

May 25th.—The Society's Medals and Awards will be presented to the recipients at the Wilbur Wright Memorial Lecture.

GRADUATES' AND STUDENTS' SECTION.

April 18th.—"The Status of the Aeronautical Engineer." Discussion opened by Mr. J. V. Connolly, B.E., A.F.R.Ae.S. Mr. A. H. R. Fedden M.B.E., D.Sc., M.I.A.E., M.S.A.E., F.R.Ae.S., in the chair. To be held in the Library of the Society, 4, Hamilton Place, W.1, at 7.30 p.m.

BRANCH LECTURES.

Southampton.

April 5th.—Lecture by Mr. M. S. Hooper, F.R.Ae.S., on "The Sailing Yacht in Comparison with the Aeroplane." Held at Air Service Training Limited, Hamble, at 7.30 p.m.

Weybridge.

Wednesday. April 12th.—Lecture by Mr. G. H. Miles, D.Sc., on "The Human Factor in Production."

Lectures are held in Senior Staff Canteen, Vickers' Works, Weybridge, at 6.15 p.m.

The attention of members is drawn to the following lecture:—

April 5th.—Lecture before the Institution of Electrical Engineers Wireless Section by Mr. N. F. S. Hecht, on "Radio in Aviation," at 6 p.m., at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Light refreshments will be served at 5.30 p.m.

J. LAURENCE PRITCHARD, *Secretary and Editor*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated The Institution of Aeronautical Engineers

No. 4, Hamilton Place, London, W.1. Telephones: Grosvenor 3515/6.

MONTHLY NOTICES

MAY, 1939

National Register.

In reply to a number of letters from members, discussions are taking place with the Ministry of Labour for circulating all members and preparing a central register of those engaged in aviation who will as far as possible be reserved in case of a national emergency. It is hoped that the necessary cards will be circulated very shortly.

Membership and Associate Membership.

At the Annual General Meeting held on March 29th, 1939, a Resolution was proposed and carried that the Council should draft the necessary Rules to abolish the grades of Membership and Associate Membership and that existing Members and Associate Members should be transferred to the Fellowship and Associate Fellowship grades respectively.

A Resolution was also passed recommending to the Council that the Rules for Associate Fellowship should be amended so that those with long experience in aviation and who have reached positions of responsibility may be eligible for election, though they have not passed the Associate Fellowship examination nor an exempting examination.

Notice of a Special Meeting to amend the Rules will be sent to all members as soon as the necessary alterations have been prepared.

Lecture Programme.

The Council have under consideration the lecture programme for the coming session and will be glad to receive suggestions for lectures.

Garden Party, May 14th, 1939.

On Sunday, May 14th, 1939, the Royal Aeronautical Society will hold its Annual Garden Party at the Great West Aerodrome, near Hayes, Middlesex, by kind permission of Mr. C. R. Fairey, M.B.E., F.R.Ae.S.

Among the machines which will be demonstrated or shown at the Garden Party it is expected the following will appear:—

Demonstrations by formations of Spitfire Fighters and Blenheim Fighter-Bombers, kindly arranged by the Air Ministry.

Blackburn Aircraft Company are sending a "Skua"; Bristol Aeroplane Company, the Blenheim; De Havilland Aircraft Company, Moth Minor and other De Havilland aircraft; Cierva Autogiro Co., Ltd., Autogiro C 40; Arpin & Co., Arpin Experimental aircraft; Boulton Paul Aircraft, Ltd., the Defiant; Chilton Aircraft, Ltd., Chilton Monoplane; Foster Wikner Aircraft, Ltd., 1939 Wicko; General Aircraft, Ltd., Cygnet (Tricycle Undercarriage), Pressure Cabin Machine; Hawker Aircraft, Ltd., Hurricane; Luton Aircraft, Ltd., Luton Major and Buzzard; Moss Brothers Aircraft, Ltd., Moss Pobjoy Sports and Moss Cirrus Trainer; Percival

Aircraft, Ltd., Percival Q6, Vega Gull and Mew Gull; Phillips and Powis Aircraft, Ltd., Miles Master I, Magister; Tipsy; Stinson; Vickers-Armstrong Wellington and Spitfire; Fairey Battle and P4/34 and Firefly; Taylor-Watkinson Dingbat; Westland Aircraft, Ltd., Lysander II; Imperial Airways De Havilland Frobisher; British Airways, Lockheed 14; K.L.M., D.C.3; Air France, Bloch 220; Willoughby Delta, St. Francis; R. G. J. Nash, pre-war and war time aircraft; R. O. Shuttleworth, pre-war and war time aircraft; Reid and Sigrist Twin-engined Trainer; Taylorcraft Plus; Benes-Mráz Bibi Be-550; Messerschmidt Taifun; Handley Page Hampden I; Bücker Jungmann; Klemm Kl. 35 B; Fairchild 24.

Many firms have made arrangements to show some of their more interesting technical and scientific products in the static display which is being organised.

Tickets for the Garden Party can only be obtained through members of the Society. The price of the tickets is 5/- each (including tea).

It would greatly help the work of the staff if members would apply for their tickets at once as last year there were so many applications for tickets at the last minute that it was not possible to supply them all.

Council Meeting.

A meeting of the Council was held in the Offices of the Society on Wednesday, April 26th, 1939. The following members were present:—Mr. A. H. R. Fedden (President) in the chair, Captain P. D. Acland, Professor L. Bairstow, Mr. Griffith Brewer (Vice-President), Mr. S. Camm, Mr. D. L. Ellis, Mr. A. Gouge, Mr. F. Handley Page, Professor F. T. Hill, Air Vice-Marshal R. M. Hill, Lieut.-Colonel J. T. C. Moore-Brabazon, Major B. W. Shilson, Mr. F. M. Thomas, Dr. H. C. Watts, Mr. H. E. Wimperis (Past-President), Mr. L. A. Wingfield (Solicitor), Mr. R. T. Youngman.

Among the business discussed was the following:—Report of the 1940 Conference Committee; Report of the Finance Committee; Report of the Grading Committee; Resolutions from the Annual General Meeting; Appointment of Committees of Council and representatives on other bodies.

Election of Members.

The following members were elected at a meeting of Council held on Wednesday, April 26th, 1939:—

Fellows.—Albert George Elliott, George Edward Petty (from Associate Fellow).

Associate Fellows.—George William Barber, Handel Davies (from Student), Maurice Larwood Gaine (from Associate), Harry Cecil Harrison, Harry Higgins (from Associate), John Hogan, George Leslie Keen, Kenneth Malise St. Clair Graeme Leask, Percy Hargrave Legg, William Perrin Lewis (from Associate), George Ashley Mann, Matthew Lee Murphy, William Charles Sharp, Alan Howard Stratford (from Student), Austin George Alan Tawell, John Edgeworth David Touche.

Associate Members.—James Diaper (from Student), Leslie Reginald Bloomfield Ford, Henry Hamilton Clifford Hester, Leonard Taylor.

Associates.—Henry Eccarius Bolton, Albert Edward York Bramble, Guy Thornton Walpole Champneys (from Student), Harold Cecil Comben, Bertram Cornthwaite (from Student), Gerald FitzGerald-Lee, Jagnath Mathur, Anthony Cory Myers, Sydney Oldfield, Albert Edward Shepherd, James Hay Stevens (from Student), William Arthur Jevons Street (from Student).

Graduates.—Eric Raymond Arbon (from Student), Leslie Frederick Atkinson, Hubert William Jordan Brittlebank from Student), Elfyn John Richards (from Student).

Companion.—Edward Stephen Wilkins.

Students.—William Astley, James Arthur Beardsall, Richard Harold Botterill, Edward York Bramble, Edgar P. Bridgland, Dudley Ransford Hudson de Fonseka, William Leonard Howells, David Cumming Jennings, Clifford Henry Clive Jennings, William Taylor Kirkby, Ronald Sinclair Massey, Robert William Molyneux, Peter Fyfe Mouritz, George Herbert Palk, Richard Gabriel Robinson, David Moline Warner, Ian Neville Way, John Victor Price Williams.

Wilbur Wright Memorial Lecture, 1939.

The 27th Wilbur Wright Memorial Lecture will be given by Dr. G. W. Lewis, F.I.Ae.S., President of the Institute of the Aeronautical Sciences, on Thursday, May 25th, 1939. The subject of the lecture will be " Some Modern Methods of Research in the Problems of Flight."

The lecture will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, at 6.30 p.m. (by permission of the Council of the Institution), and will be followed by the Annual Council Dinner at 4, Hamilton Place, W.1.

Thomas Gray Memorial Trust.

The Council of the Royal Society of Arts offer various prizes under the Thomas Gray Memorial Trust, the objects of which are " The advancement of the science of navigation and the scientific and educational interests of the British Mercantile Marine." Full particulars may be obtained from the Secretary, Royal Society of Arts, 18, John Street, Adelphi, W.C.2.

Acknowledgments.

The Council acknowledge with grateful thanks a copy of " Dedication of the Wright Brothers' Home and Shop in Greenfield Village, U.S.A., 1938," from Mr. Griffith Brewer, Vice-President. This copy contains a print from the original negative of the first flight by a heavier-than-air craft on December 17th, 1903. They also wish to acknowledge from Mr. F. R. Simms, Founder Member and Member, a copy of his Patent No. 1,639, of 1909, the first patent for a " joy-stick " taken out in this country; and from Mr. W. O. Manning, Fellow, a copy of " Air Bubbles and Buoys," published by Spencer Bros., Ltd. The Council also acknowledge with grateful thanks the gift of an original copy of the reprint of the paper read by Mr. F. W. Brearey at the second meeting of the Society (Feb. 28, 1866), containing also a subscription form and a notice of the first meeting (Jan. 12th, 1866), from Sir Frank McClean. This is now on view in the Library, with other interesting relics of the Society's early days.

Additions to the Library.

National Advisory Committee for Aeronautics: Technical Notes:—

No. 673. The Pressure Available for Ground Cooling in Front of the Cowling of Air-Cooled Airplane Engines. By G. W. Stickle and U. T. Joyner.

No. 674. Scavenging a Piston-Ported Two-Stroke Cylinder. By A. R. Rogowski and C. L. Bouchard.

No. 676. Discharge Characteristics of a Simulated Unit Injection System. By Edred T. Marsh.

No. 677. Tests of a Contra-Propeller for Aircraft. By William M. Benson.

No. 678. Hydrodynamic and Aerodynamic Tests of Four Models of Outboard Floats. (N.A.C.A. Models 51-A, 51-B, 51-C and 51-D.) By John R. Dawson and Edwin P. Hartman.

No. 679. Noise from Propellers with Symmetrical Sections at Zero Blade Angle, II. A. F. Deming.

National Advisory Committee for Aeronautics: Reports:—

No. 630. A Flight Comparison of Conventional Ailerons on a Rectangular Wing and of Conventional and Floating Wing-tip Ailerons on a Tapered Wing. By H. A. Soule and W. Gracey.

No. 639. The Effect of Compressibility on Eight Full-Scale Propellers Operating in the Take-off and Climbing Range. By D. Biermann and E. P. Hartman.

No. 640. The Aerodynamic Characteristics of Full-Scale Propellers having 2, 3 and 4 Blades of Clark Y and R.A.F. 6 Airfoil Sections. By E. P. Hartman and D. Biermann.

No. 642. Tests of Five Full-Scale Propellers in the Presence of a Radial and a Liquid-Cooled Engine Nacelle, including Tests of Two Spinners. By D. Biermann and E. P. Hartman.

No. 644. The Torsional and Bending Deflection of Full-Scale Aluminium Alloy Propeller Blades Under Normal Operating Conditions. By E. P. Hartman and D. Biermann.

No. 645. Correction of Temperatures of Air-Cooled Engine Cylinders for Variation in Engine and Cooling Conditions. By O. W. Schey, B. Pinkel and H. H. Ellerbrook, Jr.

No. 648. Design Charts for Predicting Downwash Angles and Wake Characteristics Behind Plain and Flapped Wings. By A. Silverstein and S. Katzoff.

Aeronautical Research Committee: Reports and Memoranda:—

No. 1834. An Analysis of the Stresses in a Flat Plate with a Reinforced Circular Hole Under Edge Forces. By C. Gurney.

Meteorological Office Professional Notes:—

No. 88 (M.O. 420h). Fog on the Mainland and Coasts of Scotland. By F. E. Dixon. H.M.S.O., 6d. 1939.

Meteorological Office:—

M.O. 432 (A.P. 1699). Meteorology for Aviators. By R. C. Sutcliffe. H.M.S.O., 7/6. 1939.

Smithsonian Institution, Washington:—

Publication No. 3526. The Sunspot Period. By H. H. Clayton. 1939.

Smith College, Northampton (Mass.), U.S.A.:—

Classical Studies No. 12. Navis Aeria of B. Zamagna. Translated by Mary B. McElwain. 1939.

The National Physical Laboratory. Report for the Year 1938. H.M.S.O., 2/6. 1939.

Aero-Engines (Vol. II). Various Authors. Chas. Griffin and Co., 1939. 18/-.

The Air Defence of Britain. L. E. O. Charlton, G. T. Garratt and R. Fletcher. Penguin Books, Ltd., 1938. 6d.

An Air Fighter's Scrapbook. Ira Jones. Nicholson and Watson, 1938. 10/6.

Aircraft Handbook. F. H. and H. F. Colvin. McGraw Hill Book Co., 1928.

The Aircraft Year-Book, 1923. Edited by C. G. Grey. Sampson Low, Marston and Co., 1923.

Aluminium und Al.-Legierungen. Dr. Hans Berg. Bechhold, Frankfurt-am-Main, 1924.

Ce que tout Aviateur doit savoir. A. Lainé. Gauthier Villars, Paris. (Undated, about 1924.)

Dedication of the Wright Brothers' Home and Shop in Greenfield Village. Various Authors. The Edison Institute, Dearborn (Mich.), U.S.A., 1938.

Die Brüder Wright. A. Hildebrandt. Otto Elsner, Berlin, 1909.

Der Flieger und sein Flugzeug. E. Sohn. Volckmann, Berlin, 1916. R.M. 2.80.

Der Flugzeugführer: Instruktionsbuch für Militär und Sportflieger. Fritz Keller. Volckmann, Berlin, 1917. R.M. 2.80.

Descrizione ed Istruzioni per l'Impiego del Paracadute "Salvator D.30." Ministero dell'Aeronautica, Rome, 1934.

Dictionnaire de l'Aviation. A. Lainé. Charles-Lavauzelle, Paris. (Undated, about 1920.)

The Drama of Weather. (2nd Edition.) Napier Shaw. Cambridge University Press, 1939. 10/6.

L'Évolution de l'Aéronautique. Marcel Jauneaud. Flammarion, Paris, 1923. Fr. 7.50.

Explorations of the Upper Atmosphere. H. de Graffigny. Smithsonian Institution, Washington, 1898.

Flugdienst von Heute. (Vol. II of Series "Verkehr und Wissen.") Willy Meyer. Verkehrwissenschaftliche Lehrmittelgesellschaft, Berlin, 1930.

Die Kriegsernährungswirtschaft 1917. Kriegsernährungsamt. 1917.

Lageskizzen europäischer Flugplätze. W.G.L., Berlin, 1927.

Les Aérostiers Militaires du Château de Meudon (1794-1884). Désiré Lacroix Auguste Ghio, Paris, 1885.

Les Aérostiers Militaires en Égypte. (Campagne de Bonaparte, 1798-1801.) M. de Villiers du Terrage. G. Camproger, Paris, 1901.

Lighter than Air (The Aviators Guyed). H. Maitland. London and Norwich Press, 1912.

Lighter than Air. Stephen Wilkinson. A. H. Stockwell, Ltd., 1939. 6/-.

Luftbild und Vorgeschichte. Published by Hansa Luftbild, G.m.b.H., 1938.

The Modern Diesel. (5th Edition.) Iliffe and Sons, Ltd., 1939. 3/6.

Night Flight (and other Verse). Leonard Taylor. Air Review, 1939. 3/6.

Prévision du Temps par l'Analyse des Cartes Météorologiques. J. van Mieghem. Gauthier-Villars, Paris, 1936.

A Primer of the Internal Combustion Engine (New Edition). H. E. Wimperis, C.B.E., and W. J. Stern, B.Sc. Constable and Co., Ltd., 1939. 5/-.

Ricerche di Areonautica (*sic*). A. Bertelli. Unione Tipo Litografica Bresciana, 1903.

Some Aeronautical Experiments. Wilbur Wright. (Reprint of Lecture given in 1901.)

Störungen am Flugmotor. Dr. Fritz Huth. R. C. Schmidt, Berlin, 1926. R.M. 4.00.

Das Sportflugzeug. A. Gymnisch. R. C. Schmidt, Berlin, 1926. R.M. 4.00.

The Story of the Winged-S. Igor Sikorsky. Dodd, Mead and Co., New York, 1938. $3.00

This Flying Game. Brigadier-General H. H. Arnold and Major Ira Eaker. Funk and Wagnalls, New York, 1936. $3.00.

Traité théorique et pratique de Navigation Aérienne. H. de Graffigny. Eyrolles, Paris, 1928.

Vom Fliegen und Flieglernen. Hermann Fricke. Gerhard Stalling, Oldenburg, 1927.

Also the following Publications in Russian:—

Diagrams for Use in Calculations of Operating Characteristics of Aircraft Engines at Altitude. By M. M. Maslennikov. 1935.

A Study of the Effect of Additions on the Combustion of Air-Methane Mixtures Under Pressure. By N. Schmigelski and K. Chukaev. 1934.

Methods of Correcting Cylindrical Gear Wheels with Straight Teeth. (External Meshing.) By A. N. Kaluzhnikov. 1935.

The Dynamics and Stress and Design Calculations of Aircraft Engines: Part I, The Kinematics and Dynamics of Aircraft Engines; Part II, Stress and Design Calculations. By Professor I. Sh. Neyman. 1933.

The Working Cycle of a Diesel Engine. By A. D. Charomsky. 1935.

Transactions of the Heavy Oil Engine Department. Various Authors. 1934.

Collective Report No. 1 of the Central Institute for Construction of Aero Engines. Various Authors. 1936.

All the above published by the Onti N.K.T.P., U.S.S.R.

Forthcoming Events.

May 4th.—Lecture before the Society by Mr. H. L. Cox on "Strength of Thin Metal Construction," at 6.30 p.m. in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1 (by permission of the Council of the Institution). Light refreshments will be served from 6 p.m.

May 8th.—Finance Committee Meeting at 5.30 p.m.

May 10th.—Council Meeting at 5.30 p.m.

May 14th.—**Garden Party.**—On Sunday, May 14th, 1939, the Royal Aeronautical Society will hold its Annual Garden Party at the Great West Aerodrome, near Hayes, Middlesex, which has been kindly lent by Mr. C. R. Fairey, M.B.E., F.R.Ae.S., for the occasion.

May 17th and 18th.—Associate Fellowship and Associate Membership Examinations of the Royal Aeronautical Society, at Imperial College of Science and Technology, South Kensington, S.W.7.

May 25th.—Wilbur Wright Memorial Lecture. Dr. G. W. Lewis, F.I.Ae.S., on "Some Modern Methods of Research in the Problems of Flight." The lecture will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, at 6.30 p.m. Refreshments at 6 p.m.

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J. Laurence Pritchard, *Secretary and Editor*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated The Institution of Aeronautical Engineers

No. 4, Hamilton Place, London, W.1. Telephones : Grosvenor 3515/6/7.

MONTHLY NOTICES

JUNE, 1939

Office Closing.

The Offices of the Society will be closed on Friday, June 16th, and Saturday, June 17th. In the evenings of these days the President and Council will be holding receptions to members, particulars of which are given below.

President.

At the May meeting of Council, Mr. A. H. R. Fedden, M.B.E., D.Sc., M.I.A.E., M.I.Mech.E., M.S.A.E., F.R.Ae.S., President of the Society was elected for a second year of office from October, 1939, to September, 1940.

Vice-Presidents.

At the May meeting of Council, Mr. Griffith Brewer, Hon. F.R.Ae.S., Vice-President of the Society, was elected for a second year of office from October, 1939, to September, 1940, and Air Vice-Marshal R. M. Hill, M.C., A.F.C., M.A., F.R.Ae.S., was elected a Vice-President for the same period.

Lecture Programme.

The Council have under consideration the lecture programme for the coming session and will be glad to receive suggestions for lectures.

Council Meeting.

A Meeting of the Council was held in the Offices of the Society on Wednesday, May 10th, 1939. The following members were present:—Mr. A. H. R. Fedden (President) in the chair; Captain P. D. Acland, Professor L. Bairstow, Mr. Griffith Brewer (Vice-President), Mr. S. Camm, Mr. W. C. Devereux, Mr. D. L. Ellis, Mr. A. Gouge, Professor F. T. Hill, Lord Sempill, Major B. W. Shilson, Mr. F. M. Thomas, Dr. H. C. Watts, Mr. H. E. Wimperis (Past-President), Mr. R. T. Youngman.

Among the business discussed was the following:—Report of the Finance Committee; Report of the Grading Committee; Resolutions from the Annual General Meeting; Meetings in 4, Hamilton Place; Election of President and Vice-Presidents.

Election of Members.

Fellow.—Archibald Edward Russell (from Associate Fellow).

Associate Fellows.—Raleigh Willoughby Hilken, Walter Stanley Hollyhock (from Associate), Cecil Thomas Locke (from Student), Peter Gordon Masefield (from Student), Helmuth Albert Martin Sachse, Thomas Stevenson Smith, Alfred Lionel Woode.

Associates.—Frederick Anson Firth, William John Gessey, Frederick Pye, Eric Skelton, Frederick Henry Buller Sorrell, Winston Walker.

Students.—Roderick William Burn-Callander, William John Ewart Craigen, William Spooner Hemp, Antony Michael Hale Lewin, William Hugh Duncan McCorquodale, Peter John Thursby, Sydney William Wild.

Companions.—Mrs. Florence Mary Morris-Davies, Albert James Payne.

Reception and Conversazione on June 16th and 17th, 1939.

The President and Council will be giving a Reception, to be followed by dancing, on Friday evening, June 16th, 1939, and Saturday evening, June 17th, 1939. So many members expressed the wish to attend the formal opening of the Society's new headquarters that it was found impossible to arrange for all to come on one evening without uncomfortable crowding. The arrangements for both evenings will be exactly the same in every way, and the President and Council hope that by giving two evenings to the Reception that every member will have a full opportunity of seeing their new home in comfort.

The Reception begins at 8.30 p.m. and dancing will begin at 9.30 p.m. and continue to 1.30 a.m. each evening.

Telephones for the Convenience of Members.

The increase of the work of the Society has made it necessary to have another line. The telephone numbers of the Society are now Grosvenor 3515, 3516 and 3517.

For the convenience of members a special telephone has been fitted, so that they can make their own personal calls when visiting the Society's offices. This telephone number is Grosvenor 3770.

Busk Studentship in Aeronautics, 1939-1940.

A vacancy has arisen for the Busk Studentship in Aeronautics. The Studentship is of the value of about £150, tenable for one year and the object of the Studentship is to enable the holder to engage in research, or preparation for research in Aeronautics. Further particulars may be obtained from Professor B. Melvill Jones, F.R.Ae.S., Engineering Laboratory, Cambridge.

Library.

The Library will be closed on Saturday afternoons from Saturday, June 24th, and will re-open on Saturday, September 30th, 1939. Members may obtain books from the Library through the post on application. The Library will be open as usual from 9.30 to 5 o'clock from Monday to Friday and from 9.30 to 12.30 on Saturdays.

Acknowledgments.

The Council acknowledge with grateful thanks the gift by Mr. R. L. Howard-Flanders of Eiffel's " Nouvelles Recherches sur la Resistance de l'Air et l'Aviation, faites au Laboratoire d'Auteuil " (1914), and also of a photographer's armlet from the Rheims Flying Meeting of 1910.

The Council acknowledge with grateful thanks the gift of several photographs and books of historic interest, together with other up-to-date publications, from Mr. M. H. Volk. They further acknowledge a unique copy of the Programme of the First Flying Meeting at Rheims (1909), autographed by the winners of each race, kindly presented by Colonel Harry Delacombe; and a collection of photographs from Mr. G. Tilghman Richards, Fellow.

Central Register for National Service.

Members who have filled up cards of enrolment in the Central Register will recall that they were asked to state if they were already members of Territorial, Reserve or Auxiliary Forces, or under any other obligations for National Service. It is desired to keep the Central Register up to date in respect of this information and members who undertake any form of National Service which would involve *whole time service in war* are therefore requested to inform the Secretary who will pass on the information to the Ministry of Labour.

It would be appreciated if members would take similar action in respect of:—

(*a*) Change of address.

(*b*) Change of employer.

(*c*) Acquisition of additional professional qualifications.

Additions to Library.

National Advisory Committee for Aeronautics: Reports:—

No. 637. Determination of Boundary Layer Transition on Three Symmetrical Airfoils in the N.A.C.A. Full-scale Wind Tunnel. By Abe Silverstein and John V. Becker.

No. 646. The Compressibility Burble and the Effect of Compressibility on Pressures and Forces Acting on an Airfoil. By J. Stack, W. F. Lindsey and Robert E. Littell.

No. 647. Tests of N.A.C.A. 0009, 0012 and 0018 Airfoils in the Full-Scale Tunnel. By H. J. Goett and W. K. Bullivant.

No. 649. The "Pack" Method for Compressive Tests of Thin Specimens of Materials Used in Thin-Wall Structures. By C. S. Aitchison and L. B. Tuckerman.

No. 651. Downwash and Wake Behind Plain and Flapped Airfoils. By Abe Silverstein, S. Katzoff and W. K. Bullivant.

National Advisory Committee for Aeronautics: Technical Notes:—

No. 675. The Charging Process in a High-Speed, Single-Cylinder, Four-Stroke Engine. By Blake Reynolds, H. Schechter and E. S. Taylor.

No. 680. The Aerodynamic Drag of Five Models of Side Floats, N.A.C.A. Models 51-E, 51-F, 51-G, 51-H and 51-J. By R. O. House.

No. 681. A General Tank Test of a Model of the Hull of a P3M-1 Flying Boat, including a Special Working Chart for the Determination of Hull Performance. By John R. Dawson.

No. 682. The Unsteady Lift of a Finite Wing. By Robert T. Jones.

No. 683. Pressure Distribution Measurements on a Tapered Wing with a Full-Span Split Flap in Curved Flight. By Th. Troller and F. Rokus.

No. 684. Experimental Study of Deformation and of Effective Width in Axially Loaded Sheet-Stringer Panels. By W. Ramberg, A. E. McPherson and Sam Levy.

No. 685. Circulation Measurements about the Tip of an Airfoil during Flight Through a Gust. By Arnold M. Kuethe.

No. 686. Local Instability of Symmetrical Rectangular Tubes Under Axial Compression. By E. E. Lundquist.

No. 687. Loads Imposed on Intermediate Frames of Stiffened Shells. By Paul Kuhn.

No. 688. Comparative Performance of Engines Using a Carburettor, Manifold Injection and Cylinder Injection. By O. W. Schey and J. D. Clark.

No. 689. Tandem Air Propellers. By E. P. Lesley.

Publications Scientifiques et Techniques du Ministère de l'Air :—

No. 143. Étude Optique des États de Surface, application à la Corrosion. by François Canac. Frs. 15.

No. 144. Quelques Problemes d'Hydrodynamique bidimensionnelle des Fluides Compressibles. By B. Demtchenko.

Sur quelques Applications de la Méthode de l'Analogie hydraulique. By C. Woronetz. Frs. 20.

No. 145. Sur les Cavitations dans les Liquides et les Diminutions locales accentuées de Densité dans les Gaz. By D. Riabouchinsky. Frs. 30.

Attidi Guidonia. (Editoriale Aeronautica, Rome) :—

No. 2. Sulla Misura ad Alta Precisione di Frequenze Radio. By E. Montuschi.

No. 3. Criteri Moderni nell'Elaborazione delle Prove di Consumo degli Aeromobili. By V. Allara.

Publications of the Smithsonian Institution, Washington (U.S.A.) :—

No. 3138. The Periodometer : An Instrument for Finding and Evaluating Periodicities in Long Series of Observations. By C. G. Abbot. 1932.

No. 3350. Seasonal Weather and its Prediction. By Sir G. T. Walker. 1936.

No. 3354. The Upper Atmosphere. By G. M. B. Dobson. 1936.

No. 3355. The Nature of the Cosmic Radiation. By Thomas H. Johnson. 1936.

No. 3356. What is Electricity? By Paul R. Heyl. 1936.

No. 3357. New Facts about the Nucleus of the Atom. Carl D. Anderson. 1936.

No. 3358. The Approach to the Absolute Zero of Temperature. By F. Simon. 1936.

No. 3530. Utilising Heat from the Sun. By C. G. Abbot. 1939.

Bibliography of Aeronautics (U.S. Works Progress Administration) :—

Part 30. Aerial Photography.

Part 38. Skin Friction and Boundary Flow.

International Commission for Air Navigation (C.I.N.A.) : Official Bulletin No. 26. (December, 1938.)

Aerodynamik. By Otto Leib. Matthiesen, Berlin. R.M. 2.81. 1939.

Aero Engineering. Various Authors. Published by George Newnes, Ltd. 3 vols. 1938.

The Aeroplane. By T. O'B. Hubbard, J. H. Ledeboer and C. C. Turner. Longman's, Green and Co. 1911. 2/6.

Aircraft Accidents and Casualties. (Civil Aeronautics Bulletin, No. 3.) U.S. Civil Aeronautics Authority, Washington. 1938. (Pamphlet.)

Aircraft Design. Vol. I, Aerodynamics. By C. H. Latimer Needham. Chapman and Hall. 1939. 13/6.

Airman Friday. By Wm. Courtenay. Hutchinson and Co. 1937. 12/6.

An Airman's Outings. By " Contact " (Alan Bott). Wm. Blackwood and Sons. 1917.

Airports and Airways. R.I.B.A. Exhibition Catalogue. 1937.

The Airways Time-Table. Roadway Publications. 1934. 3d.

Apparatus, Supplies Dropping, Marks I and II. (A.P. 1180.) The Air Ministry. 1925. (Pamphlet.)

The Automobile Association Handbook, 1937-38. Automobile Association.

The Automobile Association Foreign Touring Guide. Automobile Association. 1932. (2/-.)

B.T.R. De-Icers for Aircraft. British Tyre and Rubber Co. 1939. (Pamphlet.)

Comfort in Travel: I, By Road (S. Garcke); II, By Rail (Lord Stamp); III, By Air (Capt. E. W. Percival). Proof of Lecture read before the Institution of Civil Engineers, March 10th, 1939.

Commercial Air Transport. By Lt.-Col. Ivo Edwards and F. Tymms. Sir Isaac Pitman and Sons. 1926. 7/6.

Copper Alloys in Engineering: Their Adaptation to Modern Requirements. By H. J. Miller. Copper Development Association Publication. No. 32. (Reprint from "The Metal Industry," Nov., 1938.)

Crystallisation of Metals. By N. T. Belaiew. University of London Press. (Undated, about 1923.)

The Design and Construction of Flying Model Aircraft. By D. A. Russell. Harborough Publishing Co. 1937. 5/-.

Design Data (Strength of Materials). Various Authors. Reprint from "Journal of Applied Mechanics," 1935-1938.

Elementary Hydrostatics. By J. Hamblin Smith. Rivington's. 1883. 3/-.

Elements of Astronomy. By Sir R. S. Ball. Longman's, Green and Co. 1891.

"Fiat" (Instructions pour l'Usage et l'Entretien du Moteur "Fiat" A-12 bis.) Published by Vincenzo Bona, Turin. 1918.

Grossflugzeuge. By Günther Bock. Vandenhoeck and Ruprecht, Göttingen. 1931.

Hispano-Suiza. (Moteurs d'Aviation Licence Hispano-Suiza, Types 150 h.p., 180 h.p., 200 h.p. and 220 h.p.) Published by Compagnie de Fives-Lille. 1918.

Inter-Imperial Communication Through Cable, Wireless and Air. By Sir Charles Bright. Fleetway Press, Ltd. (Lecture Reprint.) 1919.

Junkers. By Various Authors. V.D.I., Verlag, Berlin. 1929.

Junkers Luftverkehr Nachrichtenblatt. Sammelausgabe. 1923. Published by Junkers-Werke, Dessau.

Die Junkerswerke in Dessau. By Dr. F. W. Schultz zur Markbe. Reprint from "Jahrbuch der Schiffbautechnischen Gesellschaft." 1928.

The £ s. d. of Civil Aviation. Published by De Havilland Aircraft Co. Undated (about 1934).

The £ s. d. of Flying. By Arthur J. Swinton. The "Aeroplane" Publishing Co. 1918. 6/-.

Lanchester's "Potted Logs," Parts 1 and 2. By Dr. F. W. Lanchester. Taylor and Francis, Ltd. 2/-. 1939. (Pamphlet.)

Learning to Fly. (Fifth Edition.) By Frank A. Swoffer. Sir Isaac Pitman and Sons. 1939. 7/6.

"Lorraine." (Moteur "Lorraine," description, entretien et réglage; fonctionnement sur Avion.) 220 h.p. Société Lorraine. 1918.

Ditto, 275 h.p. Société Lorraine. 1918.

Ditto, 400 h.p. Société Lorraine. 1919.

Man's Genius (Famous Inventions and Their Development). By E. Buller-Barwick. J. M. Dent and Sons, Ltd. 1932. 7/6.

Mechanics for Engineers. By Arthur Morley. Longman's, Green and Co. 1914.

Napier "Lion" Instruction Booklet. D. Napier and Sons, Ltd. 1918. 7/6.

Ditto, Published by Ministry of Munitions (H.B. 596). 1918.

The Odd Hint to the R.A.F. By "Wing-Commander." Gieves Publishing Co. (John Hogg). 1921.

On the General Theory of a Monoplane Wing: A Theory of Slotted Aeroplane Wing. By S. A. Tschapliguine. Gauthier-Villars, Paris. 1929.

Physical and Dynamical Meteorology (Second Edition). By David Brunt. Cambridge University Press. 1939. 25/-.

Practical Air Navigation Simply Explained. By J. K. Summers. Sir Isaac Pitman and Sons. 1935. 2/6.

Properties and Strengths of Materials. By J. A. Cormack and E. R. Andrew. Macmillan and Co. 1939. 8/6.

Radio in Aviation: A General Survey, with Special Reference to the Royal Air Force. By N. F. S. Hecht. Institution of Electrical Engineers. (Lecture Proof.) 1939.

Recent Inventions. By Prof. A. M. Low. T. Nelson and Sons, Ltd. 1935. 3/6.

Sequence of Flying Instruction. Guild of Air Pilots and Navigators. (Stencil.) 1938.

Teoria e Costruzione dei Velivoli. Two vols. I, Teoria del Volo; II, Costruzione dei Velivoli. By R. Verduzio. Stabilimento del Genio Civile, Roma. 1927 and 1930.

The Theory and Use of the Complex Variable. By S. L. Green. Sir Isaac Pitman and Sons. 1939. 10/6.

War Flying in Macedonia. By Hauptmann Heydemarck. John Hamilton. (Undated.) 7/6.

Zeppelin Adventures. By Rolf Marben. John Hamilton. 1934. 3/6.

Also the following publications in Russian:—

Transactions of the Central Aero-Hydrodynamical Institute of Professor Joukowsky. 1923-1935. (Series, incomplete.)

Interplanetary Society: Visions, Legends and First Phantasies. By N. A. Rwinin. "Pechatnya," Leningrad. 1928.

Theory of Rocket Planes. By N. A. Rwinin. Leningrad Institute of Engineers. 1929.

Astronomical Navigation. By N. A. Rwinin. Izdatelstvo Akademii Nauk, Leningrad. 1932.

Civil Aviation in the Capitalist States: England, Germany, France and U.S.A. By H. P. Poletika. Gosudarstvennoe Sotscialno-Economichestkoe Izdatelstvo, Moscow. 1936.

Transactions of the Moscow Institute of Transport Engineers, Nos. XIV and XV. Edited by F. E. Dzerzhinsky. Transpechat, N.K.P.S. 1929 and 1930.

Transactions of 3rd Aerodynamic Conference, Dec., 1933. (Central Aero-Hydrodynamical Institute of Professor Joukowsky.) Edited by V. L. Alexander. U.S.S.R. People's Commissariat of Heavy Industry (Aircraft).

Transactions of First Hydrodynamic Conference, Dec., 1933. (Central Aero-Hydrodynamical Institute of Professor Joukowsky.) Edited by V. L. Alexander. U.S.S.R. People's Commissariat of Heavy Industry (Aircraft).

Transactions of Conference Concerning Speeds in Aviation, Dec., 1935. Edited by V. L. Alexander. U.S.S.R. People's Commissariat of Heavy Industry (Aircraft).

Transactions of the Institute for Utilisation of Energy, Vol. I. Edited by A. D. Pokrovsky. U.S.S.R. Academy of Sciences, Leningrad. 1933.

Applied Mathematics and Mechanics. Vol. I, No. 1. Various Authors. Head Technical-Theoretical Press, Moscow. (*Note.*—A précis of each article is given either in French or in German.)

Reports of the First Congress for Aerial Survey, Leningrad, June 14-16, 1929. Edited by A. E. Fersman. Head Institute for Geodetics and Cartography, Leningrad. 1930.

Transactions of the Head Institute for Geodetics and Cartography. (Including Bibliography of publications in other European languages.) Edited by A. E. Fersman. 1931.

The Part Played by Clouds in Illuminating the Earth's Surface. (With résumé in French.) By N. N. Kalitine. Head Institute for Geodetics and Cartography, Leningrad. 1931.

Forthcoming Events.

June 12th.—Finance Committee Meeting at 5.30 p.m.

June 14th.—Council Meeting at 5.30 p.m.

June 16th.—Reception and Conversazione at 4, Hamilton Place, W.1.

June 17th.—Reception and Conversazione at 4, Hamilton Place, W.1 (The offices will be closed on both June 16th and 17th.)

June 24th.—The Library will be closed on Saturday afternoons until September 30th, 1939.

J. LAURENCE PRITCHARD, *Secretary and Editor.*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated The Institution of Aeronautical Engineers

No. 4, Hamilton Place, London, W.1. Telephones : Grosvenor 3515/6/7.

MONTHLY NOTICES

JULY, 1939

Proposed New Rules of the Society.

At the Council Meeting held on May 10th, 1939, the Resolutions from the Annual General Meeting for abolition of the Membership and Associate Membership grades and for consideration of a new rule for admission to Associate Fellowship were further considered.

The Council adopted the resolution of the Annual General Meeting to abolish the grades of Member and Associate Member and to transfer the members now in these grades to the Fellowship and Associate Fellowship grades respectively.

A Committee was appointed to examine the Rules and to cover any points upon which, in the light of present circumstances, they think action is desirable. A Rules Committee was appointed as follows :—

Professor L. Bairstow (Chairman), *Fellow.*
Captain P. D. Acland, *Companion.*
Mr. Griffith Brewer, *Vice-President, Hon. Fellow.*
Mr. S. Camm, *Fellow.*
Mr. H. E. Wimperis, *Past-President, Fellow.*

The Council passed the following resolution :—

> " The Council agree to the admission to the Associate Fellowship of a man who has had at least fifteen years practical experience in aeronautics, is more than 40 years of age, and has a record of distinguished service, provided his nomination is supported by four Fellows of the Society."

The Rules Committee are now drafting the necessary rules and revising, where necessary, the existing rules. They will report to the Council at the September meeting.

The Rules Committee invite comment on the proposals outlined above to aid them in drafting the necessary rules.

Associate Membership.

At the meeting of Council held on June 14th, 1939, pending the putting forward of the proposed new rules at a Special General Meeting, it was decided that applications for Membership or Associate Membership should be held in abeyance.

King's Birthday Honours.

C.M.G. : Major A. R. Boyle, O.B.E., M.C.
O.B.E. : Dr. G. P. Douglas, M.C., F.R.Ae.S.

Council Meeting.

A meeting of Council was held in the Offices of the Society on Wednesday, June 14th, 1939. The following members were present :—Mr. A. H. R. Fedden

(President) in the chair; Captain P. D. Acland, Professor L. Bairstow, Mr. Griffith Brewer (Vice-President), Mr. S. Camm; Mr. W. C. Devereux, Mr. A. Gouge, Professor F. T. Hill; Lieut.-Col. W. Lockwood Marsh, Lieut.-Col. J. T. C. Moore-Brabazon, Major B. W. Shilson, Mr. H. E. Wimperis (Past-President), Mr. L. A. Wingfield, and Mr. R. T. Youngman.

Among the business discussed was the following:—Report of the Finance Committee; Report of the Grading Committee; Report of the Lectures Committee; Future Policy of the Annual Garden Party; Report of the Conference Committee.

Election of Members.

The following Members were elected at a meeting of Council held on Wednesday, June 14th, 1939:—

Fellows.—George Purves Douglas (from Associate Fellow), Arthur Veryan Stephens (from Associate Fellow).

Associate Fellows.—Ernest George Barber, John Raymond Bufton (from Student), Hal Cullen Darney, Charles Peter Graham Engelbach (from Student), Douglas James How (from Student), John Watson Leach (from Graduate), Arthur Henry Martin (from Student), John Kerr Reid, Jack William Roderick, Thomas George Ross, Denis Bonham Smith.

Associates.—Roland John Falk, Barton Stilwell Freeland, Maldon Cavendish Harley (from Companion), Henry Hollingdrake, Kenneth Charles Tecklenborough Marshall, Robert Wood Mackay, Robert Laurence Morrison, Herbert George Albert Newman, Eric Harry Oxley-Boyle, Harry Edgar William Robinson, Geoffrey Arthur Virley Tyson.

Companions.—Sidney Charles Davey, Frederick James Ellen, Victor Haefner, William Percival Hildred, Eric Lord, Edward Warburton Phillips.

Students.—Bertel Fredrik Andersin, Reginald Harrington Capp, George Dobson, Antony Martin Edwards, Denis White Little, Keith Robert Obee, Arthur Ernest Polden, Charles Frederick Toms, Marcus Nelthorpe Wilson.

Associate Fellowship and Associate Membership Examinations.

The following candidates were successful at the examinations held in May, 1939:—

ASSOCIATE FELLOWSHIP.

J. A. Channer	Aerodynamics. Pure Mathematics.
R. Clemens	Design (Aircraft) (First Place).
D. A. Clifton-Mogg ...	Strength of Aeronautical Materials and Structures.
P. L. Cronbach	Strength of Aeronautical Materials and Structures (First Place). Aerodynamics. Pure Mathematics.
H. Donovan	Pure Mathematics.
N. F. Downes	Design (Aircraft). Applied Mathematics.

S. Holman	Strength of Aeronautical Materials and Structures. Pure Mathematics.
P. K. Hunt	Pure Mathematics (First Place).
D. C. Jenkins	Strength of Aeronautical Materials and Structures. Aerodynamics (First Place). Design (Aircraft). Applied Mathematics.
J. Lansdell	Design (Aero Engines). Pure Mathematics.
P. de L. Markham ...	Applied Mathematics (First Place).
J. F. M. Oram	Design (Aircraft).
I. H. Ring	Strength of Aeronautical Materials and Structures. Design (Aircraft). Pure Mathematics.
J. Saoula	Air Transport.
A. G. Shove	Design (Aircraft). Applied Mathematics.
R. C. Sowerbutts ...	Design (Aircraft).
C. R. Tennant	Design (Aircraft).
D. E. Thackeray	Design (Aero Engines) (First Place).

ASSOCIATE MEMBERSHIP.

E. T. Smith	Pure Mathematics (First Place). Theory of Internal Combustion Engines (First Place). Design (Aero Engines) (First Place).
R. T. Weatherstone ...	Pure Mathematics.

Acknowledgment.

The Council acknowledge with grateful thanks the gift of early numbers of the Journal from Major A. R. Low, Fellow.

Major Baden-Powell Memorial Prize.

The Major Baden-Powell Memorial Prize for the student who is considered best by the examiners in the Associate Fellowship and Associate Membership Examinations has been awarded to E. T. B. Smith on the results of the May, 1939, examinations.

Elliott Memorial Prize.

The Elliott Memorial Prize has been awarded to L./A./A. Nash, L.R., of Halton. The Elliott Memorial Prize, administered by the Society, is awarded twice yearly to the apprentice at Halton who has the highest percentage of marks in the passing-out examination.

Public School Lectures.

The following is a list of lectures which have been prepared for delivery before Public Schools and other educational establishments. Others are being prepared. Each lecture is complete in itself and is illustrated by 40-50 slides and takes one hour to deliver:—

No. 1. The History of the Aeroplane.

No. 2. The Aeroplane and its Uses.
No. 3. Flying Boats and Seaplanes.
No. 4. Training R.A.F. Pilots.
*No. 5. How an Aeroplane is Made and Flies.
No. 6. A Trip into the Stratosphere.
No. 7. How an Aeroplane Flies.
No. 8. How an Aeroplane is Made.

* This lecture is a combination of Lectures 7 and 8 for those who want both together. Certain matter and slides given in Nos. 7 and 8 have been omitted so that the lecture takes no longer to deliver.

These lectures are available to any member who wishes to deliver a lecture and full particulars will be sent on application. The Society has a large collection of slides and a selection will be made, on request, on any particular aeronautical subject.

The Society arranges lectures before Public Schools and other educational establishments on request, and the Council will be grateful to any member who is willing to give one of these lectures when required.

Additions to Library—June, 1939.

Aeronautical Research Committee: Reports and Memoranda:—

No. 1840. The Lateral Stability of Highly Loaded Aeroplanes. By L. W. Bryant and A. G. Pugsley. H.M.S.O., 1938. 2/-.

No. 1845. The Protection of Magnesium Alloy Sheet Against Corrosion by the Use of Enamels Containing High Purity Chromates. By L. F. Le Brocq. H.M.S.O., 1938. 3/6.

No. 1846. The Vibration of Airscrew Blades. (Extension of the Theory given in R. & M. No. 1758.) By B. C. Carter. H.M.S.O., 1938. 1/3.

Ministère de l'Air: Publications Scientifiques et Techniques:—

No. 146. Balance des Tangentes. By Louis Sackmann. 1939. Frs. 20.

No. 147. Sur un Phénomène d'Oscillation auto-entretenue en Mécanique des Fluides réels. By Fr.-J. Bourrières. 1939. Frs. 30.

B.S.T. No. 85. Comité d'Étude du Givrage: Rapport du 19 Mai, 1938. Frs. 10.

Aero Engines: Inspection of, during Manufacture, Overhaul and Test. ("D" Licence.) 6th Edition. By. A. N. Barrett. Sir Isaac Pitman and Sons. 1939. 3/6.

The Air Annual of the British Empire, 1939. Edited by Sq.-Ldr. C. G. Burge. Sir Isaac Pitman and Sons. 1939. 21/-.

Applied Aerodynamics. By L. Bairstow. Longmans, Green and Co. 1939. £3 3s. 0d.

Complex Variable and Operational Calculus. By N. W. McLachlan. Cambridge University Press. 1939. 25/-.

Disposition of Officers at Stations late of the Royal Naval Air Service. N.2 Section, Air Dept., 25th March, 1918.

Elements of Practical Aerodynamics. (2nd Edition.) By Bradley Jones. Chapman and Hall. 1939. 18/6.

Engine Performance at High Compression Ratios. (Engineering Research Circular No. 6.) By H. E. Zuck. University of Michigan, Ann Arbor, U.S.A. 1931. $0.50. (Pamphlet.)

Flugzeugberechnung. (Two vols. bound together.) By R. Jeaschke. R. Oldenbourg, Munich. 1938.

Das Grossflugboot. By Igor I. Sikorsky. Reprint of Lecture before Lilienthal-Gesellschaft, Oct. 12th, 1938. (Bi-lingual text—English and German.)

Metal Sprayed Bearings for High Speed Operation. By Harry Shaw. Reprint of Lecture before Birmingham Chamber of Commerce, March 28th, 1939. Published by Association of Metal Sprayers.

Mitgliederverzeichnis und Bezugsquellnachweis, 1939. (List of Members and Suppliers Index: containing also Products List in six languages.) Reichsverband der Kraftfahrzeugteile-Industrie, Berlin, 1939.

Modern Italian Aircraft. (Text in English, French, German and Spanish.) Published by Consorzio Italiano Esportazioni Aeronautiche, Rome. 1939.

Nouvelles Recherches sur la Résistance de l'Air et l'Aviation, faites au Laboratoire d'Auteuil. By G. Eiffel. H. Dunod and E. Pinat, Paris. 1914.

Proceedings of the Fifth International Congress for Applied Mechanics. Edited by J. P. den Hartog and H. Peters. Chapman and Hall, 1939. 30/-.

Proceedings of the National Institute of Sciences of India. Vol. V, No. 1. 1939.

Report on Progress in Physics, Vols. 4 and 5. Edited by Allan Ferguson. The Physical Society, 1938 and 1939. 20/- each volume.

Science and the Future of Aviation. By Igor I. Sikorsky. Reprint of 12th Steinmetz Memorial Lecture, 1938.

Also the following works by General Umberto Nobile, kindly presented by the Author:—

La Sollecitazione di Flessione nei Cavi portanti dei Trasporti aerei. (Bending Stresses in Funicular Cables.) Stabilimento Tipo-Litografico del Genio Civile, Rome. 1915.

Della Quota Massima di Volo degli Aeroplani. (The Maximum Ceiling of Aeroplanes.) "L'Universelle" Imprimerie Polyglotte, Rome. 1917.

Del Costo dei Trasporti Aerei con Dirigibili. (The Cost of Air Transport by Airship.) Stabilimento Tipo-Litografico del Genio Civile, Rome. 1918.

L'Impiego dei Dirigibili nei Trasporti di Passeggieri. (The Use of Airships in Passenger Transport.) Stabilimento Tipo-Litografico del Genio Civile, Rome. 1921.

L'Avvenire dei Trasporti Aerei nei Servizi Pubblici. (The Future of Air Transport in Public Services.) Stabilimento Tipo-Litografico del Genio Civile, Rome, 1921.

Sugli ultimi Progressi realizzati in Italia nella Tecnica costruttiva dei Dirigibili. (Recent Progress in Airship Construction in Italy.) Stabilimento Tipo-Litografico del Genio, Civile, Rome, 1923.

Il Volo Traspolare. (Our Transpolar Flight.) Stabilimento Tipo-Litografico del Genio Civile, Rome, 1925.

Alcuni primi Risultati di Collaudo dell'Aeronave "N.1." (Some first Test Results of the Airship "N.1." Mariotti, Pisa, 1923.

Recent Progress in Airship Construction in Italy. (Reprint of Paper read at International Air Congress, London, 1923.)

Della Quota di Tangenza di un' Aeronave. (The Ceiling of an Airship.) Stabilimento Tipo-Litografico del Genio Civile, Rome, 1924.

Prove di Ormeggio Funicolare per Dirigibili. (Tests of Mooring Ropes for Airships.) Tipografia Befani, Rome, 1923.

Contributo sperimentale allo Studio delle Variazioni di Carico Utile di un' Aeronave in Dipendenza delle Condizioni Atmosferiche ambienti. (An experimental contribution to the study of Variations in Useful Load of an Airship, dependent upon the surrounding atmospheric conditions.) Tipografia Befani, Rome, 1925.

Sistema " Nobile " per Atterramento ed Ammaramento Meccanico di Aeronavi. (Nobile's system for the mechanical landing or mooring of an Airship.) Tipografia Befani, Rome, 1925.

Momenti statici, forze portanti dinamiche, angoli di barra singolari e velocità d'inversione di un dirigible " N." (Static moments, dynamic lift, specific helm angles and inversion speeds of a Type " N " Airship.) Tipografia del Senato, Rome, 1937.

Determinazione delle Potenze necessarie e delle Potenze disponibili per il Volo. (Determination of necessary Forces and available Forces for Flight.) Pontifical Academy of Sciences. Vatican City. (Undated; probably 1937.)

The Dirigible and Polar Exploration. American Geographical Society, 1928.

Il Dirigible italiano nelle sue più recenti realizzazioni: il tipo " N." (The most recent developments of Italian Airships: " N " type.) Provveditorato Generale dello Stato, Rome, 1926.

Sullo Sviluppo delle Costruzioni dei Dirigibili in Italia. (The Development of Airship Construction in Italy.) Provveditorato Generale dello Stato, Rome, 1926.

Sulle Variazioni termiche del Gas contenuto nella Carena di un' Aeronave e conseguenti Variazioni di Forza Ascensionale. (Thermal Variations of the Gas contained in an Airship Hull and consequent Variations of Lift.) Pontifical Academy of Sciences, Vatican City. Commentationes, Vol. I, No. 2, 1937.

Alcune Questioni attinenti alla Meccanica del Volo dei Dirigilibi. (Some Questions appertaining to the Mechanics of Dirigible Flight.) Pontifical Academy of Sciences, Vatican City. Commentationes. Vol. II, No. 1, 1938.

La Pressione del Gas nei Dirigibili. (Gas Pressure in Dirigibles.) Pontifical Academy of Sciences, Vatican City. Commentationes, Vol. III, No. 4, 1939.

La Forza ascensionale dei Dirigibili e la Quota Massima raggiungibile. (Lift in Dirigibles, and the maximum height attainable.) Pontifical Academy of Sciences, Vatican City. Commentationes. Vol. III, No. 8, 1939.

La Preparazione e i Risultati scientifici della Spedizione polare dell' " Italia." (The Preparation and Scientific Results of the " Italia " Expedition.) Mondadori, Milan. Lire 35.

J. LAURENCE PRITCHARD, *Secretary and Editor*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated The Institution of Aeronautical Engineers

No. 4, Hamilton Place, London, W.1. Telephones : Grosvenor 3515/6/7.

MONTHLY NOTICES

AUGUST, 1939

Office Closing—Bank Holiday.

The Offices and Library will be closed from Friday night, August 4th, until Tuesday morning, August 8th.

Proposed New Rules of the Society.

At the Council Meeting held on May 10th, 1939, the Resolutions from the Annual General Meeting for abolition of the Membership and Associate Membership grades and for consideration of a new rule for admission to Associate Fellowship were further considered.

The Council adopted the resolution of the Annual General Meeting to abolish the grades of Member and Associate Member and to transfer the members now in these grades to the Fellowship and Associate Fellowship grades respectively.

A Committee was appointed to examine the Rules and to cover any points upon which, in the light of present circumstances, they think action is desirable. A Rules Committee was appointed as follows :—

Professor L. Bairstow (Chairman), *Fellow.*
Captain P. D. Acland, *Companion.*
Mr. Griffith Brewer, *Vice-President, Hon. Fellow.*
Mr. S. Camm, *Fellow.*
Mr. H. E. Wimperis, *Past-President, Fellow.*

The Council passed the following resolution :—

> " The Council agree to the admission to the Associate Fellowship of a man who has had at least fifteen years practical experience in aeronautics, is more than 40 years of age, and has a record of distinguished service, provided his nomination is supported by four Fellows of the Society."

The Rules Committee are now drafting the necessary rules and revising, where necessary, the existing rules. They will report to the Council at the September meeting.

The Rules Committee invite comment on the proposals outlined above to aid them in drafting the necessary rules.

Society of British Aircraft Constructors' Scholarships.

The Scholarships Selection Committee of the Society of British Aircraft Constructors and the Royal Aeronautical Society have made awards of Society of British Aircraft Constructors' Scholarships to the following :—

Frank Ashton, 5, Back Street, Chorley, Lancashire.
Peter Reyner Banham, 25, Larkman Lane, Norwich, Norfolk.
Gabriel Lancaster, 6, Dunlop Avenue, Lenton Boulevard, Nottingham.
Denis Moore, 129, Victory Avenue, Paddock, Huddersfield.
Geoffrey Westwood, " Glenmay," Amblecote Road, Quarry Bank, Staffs.
Raymond Wilks, 5, Jubilee Crescent, Killamarsh, Sheffield.

The Scholarships are designed for the assistance of young men who are unable, for financial reasons, to take up a course of education fitting them to become aircraft engineers.

Candidates for scholarships had to be British Subjects between the ages of 16 and 18 on the 1st September in the year of the award.

A minimum of four scholarships a year of varying value up to a maximum value of £100 each per annum is awarded.

Scholarships are tenable with certain selected firms.

All holders of S.B.A.C. scholarships are expected to qualify for a technical grade in the Royal Aeronautical Society.

Entry forms and the general regulations for applying for one of these scholarships may be obtained from the Secretary.

Acknowledgments.

The Council acknowledge with grateful thanks the gifts of books for the Library from the following members:—Mr. T. Henry Turner, Mr. V. H. Haefner, and Mr. H. J. Wolfsohn, and gifts of Journals from Major R. H. Mayo, Fellow, and Mr. G. C. D. Russell, Associate Fellow.

The Council wish specially to acknowledge the generous gift, in twelve volumes, of extra-illustrated volumes of Tissandier's "Histoire des Ballons" from Dr. Poynton. These volumes are unique and contain many rare and interesting illustrations of original texts showing the development of aviation from the earliest mythological times until 1939.

The generous gift of these volumes, the result of many years' work on the part of Dr. Poynton, will be of outstanding value to the Library of the Society. The volumes are a mine of information on the growth of aviation and it is hoped to prepare a fuller description of them shortly for publication in the Journal, together with notes on the Library of the Society generally, a library which contains the greatest collection of aeronautical literature in the world.

Public School Lectures.

The following is a list of lectures which have been prepared for delivery before Public Schools and other educational establishments. Each lecture is complete in itself and is illustrated by 40-50 slides and takes one hour to deliver:—

No. 1. The History of the Aeroplane.
No. 2. The Aeroplane and its Uses.
No. 3. Seaplanes and Flying Boats.
No. 4. How an Aeroplane is Made and Flies.
No. 5. Training Pilots for the R.A.F.
No. 6. A Trip into the Stratosphere.
No. 7. How an Aeroplane Flies.
No. 8. How an Aeroplane is Made.
No. 9. The Story of Flight.
No. 10. Balloons and Airships.
No. 11. Careers in Aeronautics.
No. 12. The Development of Commercial Aviation.

(No. 4 is a combination of Nos. 7 and 8. Certain matter and slides have been omitted so that the lecture takes no longer to deliver.)

These lectures are available to any member who wishes to deliver a lecture and full particulars will be sent on application. The Society has a large collection of slides and a selection will be made, on request, on any particular aeronautical subject.

The Society arranges lectures before Public Schools and other educational establishments on request, and the Council will be grateful to any member who is willing to give one of these lectures when required.

Additions to the Library.

Reports and Memoranda of the Aeronautical Research Committee:—

No. 1848. The Principles of the Galerkin Method. By Professor W. J. Duncan. 3/6.

No. 1851. Simple Experimental Analysis of the Stresses in Rings. By A. J. S. Pippard and S. R. Sparkes. 2/6.

No. 1855. Experiments on a Riveted Wing in the Compressed Air Tunnel. By D. H. Williams and A. F. Brown. 9d.

No. 1856. Qualitative Experiments on "Reed Oscillation" of Elevators. By W. J. Duncan and W. Barnard. 9d.

No. 1858. Longitudinal Flow in a Trailing Vortex. By W. F. Hilton. 1/-.

Ministère de l'Air: Publications Scientifiques et Techniques:—

No. 148. Contribution à la Mesure des Chaleurs spécifiques des Gaz à temperature élévée. By Aurel D. Potop. Frs. 20.

No. 149. Contribution expérimentale à l'Étude de la Combustion dans les Moteurs à Injection. By. R. Duchène. Frs. 15.

No. 150. Étude des Champs aérodynamiques par les Méthodes interférentielles. By Jean Dupuy. Frs. 35.

U.S. Works Progress Administration: Bibliography of Aeronautics:—

Part 19, Control Surfaces. Part 20, Slots and Flaps. Bound in one volume. 1938.

Part 25, Air Navigation. Part 26, Flight Instruments. Bound in one volume. 1939.

Part 41, Comfort in Aircraft. 1939.

Technical Publications of "Joseph Pilsudski" University, Warsaw (in Polish):—

No. 1. Lotnictwo w Zyciu Krajow Zamorskich. (Aviation and the Colonial Problem.) By Prof. R. Rybarsky. 1938.

No. 2. Administracyjne Prawo Lotnicze. (Administrative Aerial Law.) By B. Wasiutynsky. 1939.

Scientific Papers of the Bureau of Standards, Washington, U.S.A.:—

No. 335. Effect of Rate of Temperature Change on the Transformations in an Alloy Steel. By Howard Scott. 1919. 5 cents.

No. 337. Constitution and Metallography of Aluminium and its Light Alloys with Copper and with Magnesium. By P. D. Merica, R. G. Waltenberg and J. R. Freeman. 1919. 10 cents.

No. 347. Heat Treatment of Duralumin. By P. D. Merica, R. G. Waltenberg and H. Scott. 1919. 10 cents.

No. 394. Air Forces on Circular Cylinders, Axes Normal to the Wind, with special reference to Dynamic Similarity. By H. L. Dryden. 1920. 5 cents.

Nachrichten für Luftfahrer, Reichsluftfahrtministerium, Berlin. No. 13, 1934. Abzeichen für Zivil- und Militär-Luftfahrzeuge.

Aerial Milestones. Published by Handley Page, Ltd. (Pamphlet.) Undated (about 1921).

Aeronautical Progress, 1914 to 1930. By R. V. Southwell. (The James Forrest Lecture, 1930.) Institution of Civil Engineers. 1931.

Aero-Structures. Vol. II, Aircraft Design. By C. H. Latimer-Needham. Chapman and Hall. 1939. 16/-.

Determination of the Altitude of Aeroplanes. By Robert W. Willson. American Academy of Arts and Sciences. Vol. 47, No. 2. 1911.

The Determination of Torsional Stresses in a Shaft of any Cross Section. By L. Bairstow and A. J. S. Pippard. Institution of Civil Engineers. (Excerpt, Vol. 214, 1921-22, Part 2.) 1922.

Discontinuous Fluid Motion Past a Bent Plane, with special reference to Aeroplane Problems. By G. H. Bryan and R. Jones. Royal Society, Vol. 91. 1915.

Engineers and Empire Development. By Sir Alexander Gibb. (Presidential Address.) Institution of Civil Engineers. 1936.

Fluggeschwindigkeit. By Arnold Samuelson. Sengebusch, Schwerin. 1909.

Guynemer, Knight of the Air. By Henry Bordeaux. (English translation by Louise M. Sill.) Chatto and Windus. 1918. 3/6.

Interim Report on Wave Pressure Research. By R. A. Bagnold. Institution of Civil Engineers. 1939.

An Introduction to Astronomical Navigation. By P. H. Legg, B.Sc. Chapman and Hall, Ltd. 1939. 10/6.

Jahrbuch 1938 der deutschen Luftfahrtforschung. Published by R. Oldenbourg, Munich. 1939. R.M. 50.

The Longitudinal Stability of Aerial Gliders. By G. H. Bryan and W. E. Williams. Extract from Proceedings of the Royal Society, Vol. 73. 1904.

Luftfahrt-Fachheft. Vol. 15, No. 10 of "Deutsche Motor Zeitschrift," Oct., 1938. R.M. 2.00.

Die Luftmächte: Europas, Asiens, Amerikas, Afrikas, Australias. Published by Verlag Bernard and Graefe, Berlin. 1939. R.M. 1.75.

Luftverkehrsgesetz und Verordnung über Luftverkehr. By H. Döring. C. H. Beck'sche Verlagsbuchhandlung, Munich. 1937. R.M. 8.50.

Magnesium, Magnesite and Dolomite. By J. Lumsden, B.Sc. Imperial Institute (Mineral Resources Dept.). 1939. 2/6.

The Mechanics of the Voussoir Arch. By A. J. S. Pippard, E. Tranter and L. Chitty. Institution of Civil Engineers. 1939.

Memorandum by the Secretary of State for Air on the Report of the Committee on Control of Flying. (Cmd. 6045.) H.M.S.O. 1939. 1d.

Metal Aircraft for the Mechanic. By J. Healey. Sir Isaac Pitman and Sons. 1938. 5/-.

Die Nicht-Eisen-Metallwirtschaft der Sowjetunion. By Dr. Oleg Höffding. Carl Nieft, Bleicherode am Harz. 1939.

Night Flight. By A. de Saint-Exupéry. (Fiction.) Penguin Books, Ltd. 1939. 6d.

The Optimum Size of Models for Studying Flow through Nests of Tubes. By R. Pendennis Wallis. Reprint from "Engineering," April 28, 1939.

Principles of a Really Useful Method of Aerial Navigation, with a Brief Description of a Contrivance Based on Them. By K. S. Sanghani. Sanj Vartaman Press, Bombay. 1909.

Particulars of the Flying Machine Invented by Max Bourcart, of Colmar (Alsace). By Max Bourcart. Printed pamphlet (no identification of publisher). 1904.

The Problem of Flight. By Jose Weiss. King, Sell and Olding, London. 1908.

Progress in Aeronautical Engineering: Engineering Developments of the Army Air Corps. By Major C. W. Howard. (Official American Government Publication.) 1933.

Resistance of Air and the Question of Flying. By Arnold Samuelson. Spon, London. (Lecture Reprint.) 1905. 2/-.

Report of the Committee on Control of Flying. (Cmd. 5961.) H.M.S.O., 1939. 9d.

Rhön-Zauber: Segelflieger-Erinnerungen. (Light Verse on Gliding.) Verlag "Flugsport," Frankfurt-am-Main. 1931.

The Sail-Wheel Flying Machine. By G. Wellner. 1893. (Hand written manuscript, bound; apparently a translation of the original German lecture, reprinted in "Zeitschrift des Oesterreichischen Ingenieur und Architekten-Vereines," Dec. 15, 1893.)

Simple Experimental Solutions of Certain Structural Design Problems. By A. J. S. Pippard and S. R. Sparkes. Institution of Civil Engineers. 1936.

Sky Roads of the World. By Amy Johnson. W. and R. Chambers. 1939. 6/-.

Special Methods of Testing Aircraft Materials. By David M. Warner. Reprint of Lecture before American Society of Mechanical Engineers. 1931.

Statistics of Italian Civil Air Lines. Years 1927-34 inclusive. Ministero dell'Aeronautica, Rome.

Ein Stern fiel vom Himmel. By Hans Dominik. (Fiction.) Hase and Koehler, Leipzig. R.M. 2.85.

Substituted Phenylacetonitriles and Derivatives. 1-Phenyl-1-Cyanocyclopropane Alpha-Phenyl-Gamma-Hydrosybutyronitrile, Alpha-Phenyl-Gamma-Chlorobutyronitrile and Alpha-Phenylcrotonitrile. By E. C. Knowles and John B. Cloke. Rennselaer Polytechnic Institute, Troy (U.S.A.). Bulletin No. 49 (about 1932).

Theory of a Stream Line Past a Curved Wing. By Sir G. Greenhill. Advisory Committee for Aeronautics. Appendix to Report No. 19 (1910). H.M.S.O., 1916. 4/-.

I Timoni Automatici nei Dirigibili. By G. A. Crocco. Rebeschini di Turati, Milan. 1914.

Two Brave Brothers (Hon. C. S. and J. M. Rolls). By H. Fuller Morriss. Clifton Publishing House, London. Undated (about 1918). 5/-.

Ueber den Mechanismus des Widerstandes, den ein bewegter Körper in einer Flüssigkeit erfährt. By Th. von Kármán. K. Gesellschaft der Wissenschaften zu Göttingen. 1911.

Vögelflug, Luftfahrt und Zukunft. By Otto Wiener. J. A. Barth, Leipzig. 1911.

Der Wettflug der Nationen. By Hans Dominik. (Fiction.) Koehler und Amelang, Leipzig. 1933.

Wir Flieger! 1914-1918. (Der Krieg in Fliegerlichtbild.) By Fritz Baur. Selbstverlag, Vienna. 1930. Sch. 7.

Also the following publication in Russian:—

Investigation of the Phenomena Connected with the Work of Airscrew Blades. By Prof. G. A. Botezat. Glavnii Aerodrom, U.V.V.F., Petrograd. 1917.

J. LAURENCE PRITCHARD, *Secretary and Editor*

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MONTHLY NOTICES

SEPTEMBER, 1939

Lecture Programme 1939-1940.

The following lectures have at present been arranged for the first half of the Session, October, 1939—April, 1940 :—

October 4th.—Presidential Address, " Future Aeronautical Research and How it may be Most Economically Achieved." Mr. A. H. R. Fedden, D.Sc., M.B.E., M.I.A.E., M.S.A.E., F.R.Ae.S.

October 19th.—" Flight Refuelling." Sir Alan Cobham, Hon. F.R.Ae.S., and Mr. Marcus Langley, M.I.Ae.E.

November 16th.—" The Balancing of Aeroplane Control Surfaces." Mr. H. B. Irving, B.Sc., F.R.Ae.S.

November 23rd.—" Some Methods of Testing Light Alloys for Aircraft." Dr. L. Frommer and Mr. W. E. Prytherch, A.F.R.Ae.S.

November 30th.—" Organisation of Aero Engine Research and Development." Mr. A. G. Elliott, F.R.Ae.S.

December 7th.—" Aircraft Performance Calculations." Mr. R. N. Liptrot.

December 14th.—" Aircraft Production." Mr. H. J. Pollard, F.R.Ae.S.

The following lectures have also been arranged for the second half of the Session and it is hoped to announce additional lectures next month :—

" Methods of Operation of Constant-Speed Airscrews and Principal Blade Materials. Mr. F. M. Thomas and Mr. Charles.

" Aircraft Noise and Nuisance." Wing Cmdr. T. R. Cave-Browne-Cave, F.R.Ae.S.

" Recent Theoretical and Experimental Work on Turbulence." Mr. A. A. Hall, B.A.

" Possibilities of Obtaining and Using High Lift Devices." Miss H. M. Lyon, A.F.R.Ae.S., and Mr. R. H. Francis.

" Superchargers, Engines and Jets." Mr. Hayne Constant, A.F.R.Ae.S.

" Possible Steel Construction Developments in Aircraft." Dr. G. L. Kelley.

Lectures will be held in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, by permission of the Council of the Institution, at 6.30 p.m., unless otherwise stated. Light refreshments will be served between 6 and 6.30 p.m. Non-members will be admitted by ticket obtainable through a member of the Society.

Associate Fellowship and Associate Membership Examinations.

Candidates for the examinations in December, 1939, are reminded that entries must be received by the Secretary not later than September 30th, 1939.

Library.

The Library will be re-opened on Saturday afternoons on and from September 30th, 1939. The Library hours are 9.30—5 p.m. weekdays and 9.30—12.30 and 2—5 p.m. on Saturday.

Will those members who have not returned books, already due back, kindly return them at once in order to assist with the checking of Library books?

List of Members.

The new List of Members will be published on January 1st, 1940. Will members who have any alterations they wish to make in their addresses, designations, etc., kindly send in their corrections as soon as possible, as otherwise it will be assumed that their names, designations and addresses as now appearing in the List of Members are correct?

Acknowledgments.

The Council acknowledge with grateful thanks the gift of back numbers of the Society's Journal and other publications from Major B. W. Shilson, Fellow, and back numbers of the Society's Journal from Mr. G. C. D. Russell, Associate Fellow.

Proposed New Rules of the Society.

At the Council Meeting held on May 10th, 1939, the Resolutions from the Annual General Meeting for abolition of the Membership and Associate Membership grades and for consideration of a new rule for admission to Associate Fellowship were further considered.

The Council adopted the resolution of the Annual General Meeting to abolish the grades of Member and Associate Member and to transfer the members now in these grades to the Fellowship and Associate Fellowship grades respectively.

A Committee was appointed to examine the Rules and to cover any points upon which, in the light of present circumstances, they think action is desirable. A Rules Committee was appointed as follows:—

Professor L. Bairstow (Chairman), *Fellow.*
Captain P. D. Acland, *Companion.*
Mr. Griffith Brewer, *Vice-President, Hon. Fellow.*
Mr. S. Camm, *Fellow.*
Mr. H. E. Wimperis, *Past-President, Fellow.*

The Council passed the following resolution:—

> "The Council agree to the admission to the Associate Fellowship of a man who has had at least fifteen years practical experience in aeronautics, is more than 40 years of age, and has a record of distinguished service, provided his nomination is supported by four Fellows of the Society."

The proposed new rule aims at exempting from examination any man possessing the above attainments, and does not in any way affect the present age limit for Associate Fellows elected on the strength of their examination qualifications.

The Rules Committee are now drafting the necessary rules and revising, where necessary, the existing rules. They will report to the Council at the September meeting.

The Rules Committee invite comment on the proposals outlined above to aid them in drafting the necessary rules.

Forthcoming Events.

September 8th.—Finance Committee Meeting at 5.30 p.m.
September 13th.—Council Meeting at 5.30 p.m.
September 30th.—Library open on Saturday afternoons.

October 4th.—Presidential Address by Mr. A. H. R. Fedden, D.Sc., M.B.E., M.I.A.E., M.S.A.E., F.R.Ae.S., on "Future Aeronautical Research and How it may be Most Economically Achieved," at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1 (by permission of the Council of the Institution). Light refreshments will be served from 6 p.m.

Additions to Library: July, 1939.

Aeronautical Research Committee: Reports and Memoranda:—

No. 1843. Experiments on the Transition of the Laminar Boundary Layer on a Flat Plate. By A. A. Hall and G. S. Hislop. H.M.S.O., 1938. 4/-.

No. 1852. Profile and Skin-Friction Aerofoil Drags. By A. Fage. H.M.S.O., 1938. 3/6.

No. 1853. Further Development of a High-Speed Wind Tunnel of Rectangular Cross-Section. By A. Bailey and S. A. Wood. H.M.S.O., 1938. 2/6.

No. 1857. A Possible Form of High Speed Water Channel. By A. M. Binnie. H.M.S.O., 1938. 1/6.

National Advisory Committee for Aeronautics: Reports:—

No. 652. Air Flow in the Boundary Layer of an Elliptic Cylinder. By G. B. Schubauer. 1939.

No. 653. A Study of Air Flow in an Engine Cylinder. By Dana W. Lee. 1939.

No. 654. General Aeroplane Performance. By W. C. Rockefeller. 1939.

No. 658. Tests of Two Full-Scale Propellers with Different Pitch Distributions at Blade Angles up to 60°. By D. Biermann and E. P. Hartman. 1939.

National Advisory Committee for Aeronautics: Technical Notes:—

No. 690. Résumé of Air-Load Data on Slats and Flaps. By C. J. Wenzinger and F. M. Rogallo. 1939.

No. 691. Some Elementary Principles of Shell Stress Analysis, with Notes on the Use of the Shear Center. By Paul Kuhn. 1939.

No. 692. Some Fundamental Considerations in Regard to the Use of Power in Landing an Airplane. By Walter S. Diehl. 1939.

No. 693. Comparison of Profile Drag and Boundary Layer Measurements Obtained in Flight and in the Full-Scale Wind Tunnel. By H. J. Goett and J. Bicknell. 1939.

No. 694. Physical Properties of Synthetic Resin Materials. By Meyer Fishbein. 1939.

No. 695. The Effects of Some Common Surface Irregularities on Wing Drag. By Manley J. Hood. 1939.

No. 696. Torsional Stability of Aluminium Alloy Seamless Tubing. By R. L. Moore and D. A. Paul. 1939.

No. 697. The Frequency of Torsional Vibration of a Tapered Beam. By Robert P. Coleman. 1939.

No. 698. Propeller Tests to Determine the Effect of Number of Blades at Two Typical Solidities. By E. P. Lesley. 1939.

No. 699. Tests of an N.A.C.A. 23012 Airfoil with a Slotted Deflector Flap. By R. O. House. 1939.

No. 700. Theory of Automatic Control of Airplanes. By Herbert K. Weise. 1939.

No. 701. Intermittent Flow Coefficients of a Poppet Valve. By C. D. Waldron. 1939.

No. 702. Wind Tunnel Tests of Several Forms of Fixed Wing Slot in Combination with a Slotted Flap on an N.A.C.A. 23012 Airfoil. By M. J. Bamber. 1939.

No. 703. Wind Tunnel Investigation of Effect of Yaw on Lateral Stability Characteristics. (I) Four N.A.C.A. Wings of Various Plan Forms, with and without Dihedral. By M. J. Bamber and R. O. House. 1939.

No. 704. Some Notes on the Numerical Solution of Shear Lag and Mathematically Related Problems. By Paul Kuhn. 1939.

Bulletins of the University of Toronto, Faculty of Applied Science and Engineering, School of Engineering Research:—

No. 140. Further Tests on the Heat Output of Concealed Radiators. By E. A. Allcut. 1933.

No. 141. Pressure Measurements as Affected by the Location of the Piezometer Connection. By R. W. Angus, R. Taylor and C. G. Heard. 1933.

No. 142. Flow of Water Through Sudden Contractions and Enlargements, and Friction Loss in 2 in. Brass Pipe. By Robert W. Angus. 1933.

No. 143. The Relative Rigidity of Welded and Riveted Connections. By C. R. Young and K. B. Jackson. 1934.

No. 145. Observed Soil Pressures on the Deep Sewers of the North Toronto System. By C. R. Young and W. B. Dunbar. 1935.

No. 146. Old Forts in Upper Canada. By Fritz G. M. Winter.

No. 147. The Influence of Cupels on Silver Loss. By J. T. King. 1934.

No. 148. Horizontal Thrusts for Two-Hinged Arches of Various Forms. By C. R. Young and M. W. Huggins. 1935.

No. 149. Heat Insulation as Applied to Buildings and Structures. By E. A. Allcut and F. G. Ewens. 1937.

No. 150. Model Tests on Spillways in the Power Dam at Abitibi Canyon. By R. W. Angus and J. B. Bryce. 1937.

No. 151. An Investigation of the Chlorination of Spruce Wood and of the Resulting Chlorolignin. By G. V. Jansen and J. W. Bain. 1938.

No. 152. Water Hammer in Pipes, including Those Supplied by Centrifugal Pumps: Graphical Treatment. By R. W. Angus. 1938.

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